THE SUBMARINE REVIEW

APRIL 1991

A Quarterly Publication of the Naval Submarine League

THE SUBMARINE REVIEW IS A PUBLICATION
OF
THE NAVAL SUBMARINE LEAGUE

NAVAL SUBMARINE LEAGUE o Box 1146 o Annandale, VA 22003 o (703) 256-0891

EDITOR'S COMMENTS:

Change is the major subject which is highlighted in this edition of THE SUBMARINE REVIEW, and it is that change in the world as we have known it since the late 40s that will be causing great impact on our community in the near future; perhaps much more so than in other areas of the U.S. national security establishment. Indeed, the importance of understanding what is now going on can hardly be over emphasized.

Vice Admiral Dan Cooper's article leads this issue with a general picture of **what that change will mean** to the Submarine Force; and he puts forth a call to all of us to use our knowledge of submarines and what they can do to meet head-on the new challenges brought about in this era of change.

Next, Mr. Bob Murray discusses some realities of the **New World Order**, the issues that have to be faced by the country, and the probable future of the nation's maritime forces. He stresses the importance of learning the right lessons from the Gulf Crisis and specifically cites both the **increasing importance of the TRIDENT force** and the new attention which must be given to the **cruise missile potential** of our attack submarines.

The third article, by Dr. Jim Tritten of the Navy Postgraduate School's Department of National Security Affairs, treats one aspect of that general change with a welcome analysis of the current state of the Administration's new plan for the reorganization of the Unified and Specified Command structure. This highly important innovation was announced just as the Gulf Crisis started, therefore it has not received nearly the notice in the public press which it deserves. It may well be that the discussion which leads to the implementation of this **new plan will set the force level for the attack submarine force, and a new command arrangement for our strategic submarines.**

One critical result of the winds of change sweeping U.S. defense philosophy, and the manner in which the cuts in funding will be allocated, is the impact on what we should properly label "The Submarine Industrial Base." Because the industries which support modern submarines are so specialized and have become so narrowly structured, it appears that this **submarine industrial base may be in more danger than the defense industry in general.** Three articles treat this problem.

We are fortunate to have both Mr. Ed Campbell and Mr. Jim Turner, the heads of Newport News and Electric Boat respectively, express their views of the elements involved and the seriousness of the problem. In addition, Mr. Dan Curran of Raytheon addresses the complementary problem of the combat system base.

Jim Hay

■

FROM THE PRESIDENT

At this writing, in the aftermath of the swift and decisive Desert Storm victory, defense planners are once again turning their attention to the "build-down" of the armed forces, a task set aside during the conflict. Lessons learned from the Persian Gulf, such as the superb performance of the all-volunteer force, the impact of stealth on the modern battlefield, and the success of high tech weaponry, are certain to influence the final structure of the defense organization. Other considerations include an austere, and declining federal budget, the uncertainty of recent events in the Soviet Union and Eastern Europe, and the need to preserve a very fragile defense industrial base.

The Submarine Force is thoroughly immersed in this contentious issue. Thus, the League membership should be aware of the complex drivers which will determine the size and shape of the Force of the next century. To that end, the agenda for our annual Symposium in June will feature speakers who are engaged on a daily basis in the debate. Their candid views from Capitol Hill to the Pentagon, and those from beyond the Beltway, will put in perspective the dramatic decisions which will affect us all. From the Intelligence Community, what will be the real threat of the next decade? What are the new and evolving roles and missions for our SSNs? What are the latest developments in submarine technology in Europe, and where might we encounter that capability? Where does our TRIDENT SSBN force fit in the proposed Joint Strategic Command? How will the smaller Submarine Force affect officer and enlisted career planning? How will concepts for the follow-on to SSN-21 be formulated? We think we have an exciting program.

I have had the great pleasure of visiting recently two of our regional chapters; Central Florida, to present their Charter, and Pacific Southwest to address a quarterly meeting in San Diego. Clearly, the interest and enthusiasm I encountered are the keys to the growth and future success of the League. Efforts to organize a Pearl Harbor Chapter have just recently come to fruition, and a San Francisco Bay Area Chapter is just over the horizon. We are on a roll. For those who might be intimidated by the task of forming a chapter, be aware that help is available from National Headquarters, financial and administrative. The experience of the earliest chapters is there to guide you.

On August 2, 1990, President Bush, in an address to the Aspen Institute, proposed four pillars upon which the future national defense should be built: deterrence; forward presence; crisis response; and force reconstitution. Several of the concepts might be spelled SSBN or SSN. This is an exciting time to be associated with the Submarine Force. Bring your friends, and be a player.

Bud Kauderer

■

SUBMARINES AND THE FACE OF CHANGE

by Vice Admiral Daniel L. Cooper, USN(Ret.)

As even any occasionally observant couch potato can attest, the world has changed dramatically in just the last two years. The results of these changes are readily apparent by perusal of the Budget Request submitted to Congress by the Department of Defense. The specific world changes, or the synergism of one upon the other, are not as important as the whole.

There are very obvious results, however, which will continue to have major impact: the shifting balance of power; the Middle East and its instability; the deteriorating Soviet economy; the movement of third world countries to raise terrorism to an art form; and the U.S. national debt with the concomitant domestic problems.

Because of these results, or in spite of them, the U.S. defense establishment will be **vastly** changed five years from now -- from its present levels of resources and people. Even more starkly obvious will be the prompt drop from the force structure levels which had been predicted during the first five years of the 80's.

As each of the questions of cause and effect is debated ad nauseam, and the U.S. force level is markedly reduced, it is incumbent on those of us most familiar with the inherent capabilities of the submarine to ensure that the force structure debate of levels and mix is an informed one based on facts.

We must be convincingly articulate with the historic success of our force as well as with the inherent capabilities -- those present now and those planned and possible. Although I can hardly be perceived as impartial, I am convinced that the nuclear submarine force must be at the heart of the basic Navy structure. The Submarine Force must be sized and prepared to be effective in its role as the nation's pre-eminent strategic deterrent as well as in its multi-faceted tactical role. This latter must include both the highly successful independent operations of our SSNs as well as the operations which will integrate the vast capabilities into the Battle Force (land strike, ASUW and ASW).

Recently an article by Paul Wrobel, Director of Design,

Vickers Shipbuilding and Engineering, Ltd., led off with the statement:

> *"For over 100 years submarines have demonstrated their military effectiveness. From early perceptions of being largely irrelevant or even unfair in naval warfare, submarines have progressed to becoming the key units in all the world's major navies."*

Whether each of you agree fully is not important, but being knowledgeable of several basic facts is mandatory. Many countries, today, view the submarine as the most valuable naval warship. The Soviet Union not only has said it in various fora, it has backed up that opinion by actions. In 1990 the Soviet Union launched ten submarines, six of which were high performance, state-of-the-art modern nuclear submarines, both the largest number and the greatest tonnage of submarine construction seen in many years. Those submarines may not represent the major threat today; they do certainly establish the greatest potential threat. To be properly prepared we must deal with capabilities.

Let there be no doubt, both the British and French governments very strongly support their submarine forces as the premier arm of their Navy -- not to mention the role as their primary strategic deterrent.

Several other countries have programs for building new submarines and for modernizing existing forces: Germany is presently designing and building diesel units for several countries. Many others are either buying *overseas,* building their own, or being boot-strapped into their own submarine production capability. Some specific countries which are these *players* to varying degrees are India, Pakistan, Cuba, Brazil, Japan, Italy, South Korea, Israel, Egypt, China, Taiwan, Libya, Australia, The Netherlands and Norway. Obviously, these governments and others see some strong potential benefit in a pre-eminent submarine force.

A former Assistant CNO for Air Warfare wrote recently in the U.S. Naval Institute Proceedings:

> *"One of the most serious problems confronting planners today is the real and growing threat of Third World submarines.... Missiles and torpedoes launched from those submarines will undoubtedly be the principal threat to the Navy's forces at sea."*

The U.S. nuclear submarine force, as it has evolved over the last three decades, has certain capabilities that are not present in any other single platform:

- **Stealth** to an extent unknown anywhere -- allowing the U.S. submarines to operate covertly in areas, or in numbers, which no other air or naval platform can match;
- **Mobility** which has been tested frequently -- the ability to get underway rapidly, deploy fully ready at a high sustained speed and arrive at its destination prepared to operate;
- **Endurance**, which is limited only by the food carried -- and which translates to operating months at a time on station or moving from place to place - covertly; and
- **Firepower**, which now includes the D5 missile of strategic submarines and the tactical anti-ship and land-attack Tomahawk missiles, the strike version of which has been battle tested satisfactorily during Operation Desert Storm.

This tactical missile must be understood for the effect it can have. It can not deliver the weapon tonnage of DESERT STORM. It **can** operate covertly and therefore launch down an unexpected (and unprotected) axis. The Tomahawk accuracy and surprise are extremely important. Secondly, the SLCM exposes no human pilot to endangerment. If you desire a clean *no human cost*, non-attributal strike, this is it. Mines and the most sophisticated torpedoes in the world today round out the arsenal carried in our submarines.

Over the history of modern military submarining, a dichotomy in employment philosophy has been perceived by some to place primary emphasis on either independent operations or close coordination with the Battle Fleet. We must be quite clear in this age of change and enforced efficiencies to emphasize to those not as familiar with these capabilities as we, that modern USN submarines are quite capable of doing both. Indeed, that is one of the major benefits to having a large competent nuclear attack submarine force.

The Navy will continue to fulfill the historic tasks of peacetime presence, forward deployment, protection of the sea lines of communication, blockade and major fleet engagement. The United States Navy will always be required to guarantee freedom of the seas, and we have to be recognized as a primary player in that effort.

The major differences between tomorrow as now perceived, and what we had all come to expect during the mid-eighties for the Navy to execute those missions are: the Navy will be smaller (25% smaller?); many of the foreign ports which historically have *always* been accessible will no longer be available to us; the affordability issue will predominate; and the *threat* will be continuously re-defined and expressed in the light best suited to the goals of the *proponent du jour.*

As the Navy gets smaller, it is mandatory that each weapons system which supports its operations be capable of many missions as well as equipped to work with other naval forces. Interestingly, because of the very impressive submarines we now have, as well as the building program maintained during the eighties, we have an SSN level which should not decrease below seventy to eighty attack submarines over the next ten to fifteen years. A primary point to remember is that, once built and fielded, the nuclear attack submarine costs less to operate than almost any other navy ship; its range of capabilities is unmatched.

The ultimate top level of SSBNs will be determined by the ever fluid discussions of the Strategic Triad, START (I & II), the D5 building and backfit programs, and the resources allocated to "Strategic." A very major factor in the discussion of numbers will certainly be the expected reorganization of CINCSAC to CINCSTRAT as per the presently rather ill-defined JCS Unified Command Plan now being developed.

Our Submarine Force today is fully capable of missions it could not have fulfilled 15 years ago. It is much more capable and ready to work closely with Battle Forces in support of an ASW role or in coordination of anti-ship and land-strike missions. Today, the Tomahawk strike mission allows the land-based enemy to be hit from directions in which he has no fore-warning of danger. Further, SLCM land strikes preclude potential loss of American air crews. Similarly, the Dry-Deck Shelters and close operational tie with the Special Forces give the submarine operational value no other platform can emulate (the ability to insert and extract those special forces). Continuing enhancements in interoperability will only increase the submarine's value to the Navy.

Today, the U.S. nuclear Submarine Force has the full range of capabilities necessary to operate in peacetime or wartime, in

a global war or in a Third World low intensity conflict, in the open ocean or in shallow water. It can operate in our waters or theirs -- no matter who *they* are.

It is incumbent on each of us to fully understand these capabilities and where each one can fit into the National Maritime Strategy. In today's atmosphere of reduced resources and strong emphasis on efficiency and economy of forces we must ensure all the decision makers duly recognize the range of capabilities of the submarine and the strong position it must maintain in the Navy's force structure of tomorrow.

■

THE NAVY AND THE NEW WORLD ORDER

by Robert J. Murray

President Bush has expressed his hope that a new world order can be created from the defeat of Iraq and the more constructive policies of the USSR. The recent experience with Iraq is that nations acting wisely and decisively can deal with a too-ambitious and ruthless leader if they are prepared to act in common in a timely way; the hope is that success in the common endeavor can open opportunities for peace not previously present. The President has committed American leadership to work for a wider peace in the Middle East, and the creation of a better world order.

What kind of world do we want, and what is our role in it? These are important questions for us, because we are at another of life's cross-roads; a sea change is occurring in international relations, and we have choices to make. The post-war era is ending, a new era beginning. Western Europe and Japan are vigorous, Eastern Europe is free, and the Soviet empire is breaking up. These are profoundly welcome occurrences. We have played an important part in achieving them. But where from here? Will events in the USSR return us to a bipolar world, highly confrontational, or is a coalition world emerging on the model of the Gulf experience? Will we see a world in which regional powers dominate in their own region, as Iraq might have done if left unchallenged? Or an anarchic world in which no one leads? What world do we want to help create, and what is our part in the creative process? Shall we be the global policeman, trying to manage everything? Or the global fireman, ready but waiting until crises reach their burning point? Or shall our model be, as one of my colleagues puts it, the Yellowstone Fire Department -- let the fires burn? We must choose.

Making choices for this next era seems harder now than it was after the second world war. The world was a starker place then, the war had brought the need for American leadership into focus, and we were far-and-away the world's dominant economic power, with 40% of the world's gross national product. The Gulf War has been much less dramatic, much more regional, much less consequential. There is neither a vast array of devastated nations needing our help nor an over-

powering threat summoning us to commitment and sacrifice. Furthermore, although still by most measures the richest country in the world, we are deeply in debt and cash poor, with a long domestic agenda in need of attention, but little ambition for taxing ourselves further to meet these domestic needs or to pay our debts. Until we get our economy in good order, we will not be well-placed for long-term international leadership, despite the resounding success of American leadership and American arms in the Gulf crisis. This will be a process taking years, not months, and in the meantime there will almost certainly be continuing downward pressure on defense spending.

The dilemma for defense planners, therefore, is how to maintain adequate capabilities in an uncertain world with fewer resources. Moreover, some of the things that a short time ago seemed likely to help planners with this dilemma, are now less certain. For example, the START agreement long anticipated has so far not materialized, and therefore the START II negotiations that were to produce really deep cuts in nuclear weaponry cannot occur. This means we will probably be spending more of the defense budget on nuclear systems and less on conventional capabilities than would otherwise have been possible. Similarly stalled are the conventional arms negotiations in Europe, which were to agree upon and codify reductions in U.S. and other forces in Europe, and allow the demobilization of army and air units. This slow-down is also likely to influence the allocation of defense dollars in the near term.

Nevertheless, unless things go badly awry in the Soviet Union and Europe, the long-term trends are hopeful: a smaller-sized nuclear threat and therefore the need for a smaller American nuclear arsenal and (yet to be proven) a lesser percentage of the defense budget needed for nuclear forces; and a strategy for Europe that depends much more on mobilization and deployment of ground and air forces that can be maintained in normal times in the reserve components at lower cost. The challenge of designing an Army and Air Force that fits within the new circumstances and budgets is an imposing but essential one. Principal American interests will continue to be at stake in Europe, and the principal mission for both Army and Air Force will necessarily remain that of helping deter major war in Europe and of mobilizing and deploying if

things go wrong there or elsewhere.

The challenge for the Navy and Marine Corps, however, may be even more daunting, because naval missions are changing more slowly and less dramatically than army or air force missions, but naval budgets are being equally reduced. Indeed, in some ways, the strategic responsibilities of the Navy are increasing. Ironically, as the political threat from the USSR recedes, Soviet nuclear weapons programs proceed apace, and it is these weapons that represent the fundamental threat to the fabric of our society. Thus the TRIDENT submarine, the only invulnerable nuclear system we possess, and the TRIDENT missile, which with its high accuracy and long range can play a deterrent role previously reserved for the ICBM, assume a greater significance in nuclear deterrence planning, especially as we shrink the size of our nuclear arsenal. Further, as nuclear proliferation becomes a slowly evolving fact of future life, as it seems intent on doing, nuclear-equipped naval fores may be our principal theater-level deterrent to these *lesser* potential nuclear threats. (Had Iraq succeeded in its vigorous efforts to buy and steal nuclear technology and create a nuclear capability, or had Israel not destroyed Iraq's earlier attempts to create nuclear weapons, we might have faced a nuclear-armed Hussein this time round.)

Another naval responsibility increasing in strategic importance is anti-submarine warfare and sea-lane defense. This is so in two respects: first, our still-evolving strategy for NATO, relying as it does on mobilization and deployment instead of forward based army and air forces as the hedge against future crisis in Europe, is placing more importance on the safety of the sea-lanes. A European crisis seems distant at the moment, but we know beyond doubt that crises can occur there, and we know how quickly and unexpectedly crises can arise. We also know that, unlike the 1940s, when ships, planes and equipment poured daily out of yards and factories, in any new conflict we would not have access to a similar production base; every ship that goes to the bottom in a future war will be an irretrievable loss, importantly, perhaps vitally, influencing the course of battle. We could not afford to lose many ships in any major crisis. The principal strategic threat to those ships would be from submarines. We ought not to fall behind in anti-submarine warfare.

Control of the sea-lanes is important in a second respect also: regional conflict. Our military success in the Gulf depended absolutely on safe sea-lanes. Safe sea-lanes were necessary to avoid ships being sunk and to enable ships to sail. The latter is relevant because much of our sealift capacity comes from chartering civilian ships, many flying foreign flags. We had access to these ships (i.e., their owners agreed to sail) because the risk to them was low. Recall that Sherlock Holmes, in one of his remarkable, mystery-solving deductions, noted the significance of a dog that didn't bark. Well, threats to our use of the sea is another "dog that didn't bark." That it didn't do so -- that the risk to civilian ships was low -- was not an accident; it was the product of a powerful Navy. It will be useful in our defense planning if we, like Holmes, observe and be mindful of the dogs that don't bark as well as those that do.

The Gulf crisis most dramatically emphasizes the traditional naval missions of presence and crisis response. The Navy and Marines have long been, and are likely to remain, the front line representatives of American interests and commitment in most of the world. Foreign governments have welcomed American ground and air forces only in very few places, principally Germany and Korea; most countries do not feel the need or do not have the political strength to tolerate a foreign military presence within their borders. Naval sources have the great advantage of being handy without being intrusive, characteristics of considerable political advantage.

The Gulf illustrates the varied dimensions of the presence and crisis response missions. Naval forces have been in the Gulf for many decades, and have been politically important there since the late 1960s, when British forces were withdrawn from east of Suez. The Middle East Force has done the day-in, day-out job of providing American military presence and signaling American political interest in the region for all these years. Originally a small force of a flagship and several destroyer/frigate ships, it was supplemented in 1979 with the revolution in Iran and the increasing tension in the region, tension that boiled over in 1980, when Iraq attacked Iran and precipitated an eight-year war. Naval forces, U.S. and allied, kept open the oil routes through the Gulf during that war.

Again in the most recent Gulf crisis, naval forces were first on the scene, providing the initial combat-ready forces for the

early defense of Saudi Arabia, should a defense have been necessary, and the cover for the build-up of army and air forces. The naval commander facilitated the introduction of the first allied forces in the crisis, and created a coalition naval force of political importance and military effect. This coalition naval force enforced the United Nations embargo on Iraq during the months leading up to hostilities, bringing pressure on Iraq and buying time for diplomacy and for the military build-up. This naval action was the most rigorous embargo since the Cuban missile crisis, and continues though hostilities have ended and our forces are returning home.

Ultimately, we know, neither pressure nor entreaty dissuaded Hussein from his course, and the crisis became war, a war in which the coalition fores were remarkably successful. It was the first completely "joint war", with all the Services contributing in the expected and apparently well coordinated ways. The Navy and Marines chalked up some new experiences along the way, including the first operational deployment of the Maritime Prepositioning Ships for the Marines, the first employment of aircraft carriers in the northern Gulf, and the first (apparently highly successful) combat firing of Tomahawk cruise missiles from surface ships and submarines.

When the Gulf crisis is resolved, as it shortly will be, and most American forces have returned home, it will be naval forces that remain to do the presence job.

Submarines played a valuable but not large part in the Gulf crisis, as far as we know. I add "as far as we know" not because I know there is more to the story than meets the eye, but because submarines, being largely invisible, do things we cannot see; and the habit of submariners is to be silent about their missions. These two characteristics tend to make submarine operations unknown outside the Navy, and perhaps lead us to under-value submarines.

On the other hand, it is precisely the covert character of submarines that makes them unique for certain strike and strike-related missions: operating in high threat environments, gathering intelligence, delivering special forces units, evacuating people from dangerous places, rescuing downed airmen in hostile waters, etc.

Now we have the first combat firing of Tomahawks, which puts the submarine squarely into the strike mission, a fact that

would have received much more attention in a less noisy crisis. But each crisis has its own conditions and peculiarities; if the latest Gulf crisis did not require the heavy use of submarines, it is easy to envisage crises in which the submarine would be the wisest platform of choice. If analysis indicates that cruise missiles were highly successful in their tasks, there will be recommendations to buy and deploy them in much larger numbers and, down the road, to improve their performance and ease the present difficulties in their planning and handling, making them operationally more useful. Submarine planning must now incorporate the strike mission in a more vigorous way.

Picking up new missions and new capabilities is easier to propose than to accomplish. Leaner years are before us, and the shrinking defense budget will be an unrelenting task-master. We will not be able to pick up what is new without laying down something of what is old. Some still hope we will do more with less, but we will not. We will do less with less, and one obligation we have is to decide where doing less will have he lesser impact on our defense posture. Hard choices lie ahead.

If we cannot do more with less, we can do better with less. We can use our defense dollars more imaginatively, more productively, more wisely. This will require a very high order of leadership; Total Quality Leadership, like the cavalry, is arriving just in time.

In the new world order, a new order no less likely than the old to require American leadership and American armed forces will have a prominent part. The challenge is to shape them to fit the world that is coming within the budgets we can afford.

[Editor's Note: Robert Murray is a defense analyst, former Director of the National Security Program, Harvard University, former Dean of the Naval War College, and served previously as Under Secretary of the Navy.]

■

AMERICA'S NEW NATIONAL SECURITY STRATEGY

by James J. Tritten

President George Bush disclosed the outline of a new American national security strategy in his August 2, 1990 address to the Aspen Institute. The strategic concepts revealed would be **radical** and have direct and sensational impacts on NATO and our other allies. The strategy opens the door to a **complete** reconsideration of America's international role and overall military capability.

Under the new strategy, the United States would maintain much smaller active and reserve forces capable of dealing primarily with global major contingency operations, rather than deploying the types and quantities of forces it has since World War II -- primarily for a Europe-centered global war with the USSR. The U.S. now assumes that there will be sufficient time to reconstitute forces required to fight a major war against the Soviet Union -- specifically there will be **two year's warning for a future Europe-centered global war with the USSR.**

The estimated two-year warning is based upon the assumptions of withdrawal to their homeland of all Soviet ground and air forces, a conventional forces parity from the Atlantic to the Urals, an inwardly focused Soviet Union, and NATO and member nation's intelligence machinery still functioning.

A recognition by the Congress and the Administration that the level of resources devoted to defense in the last decade cannot be sustained is the major factor underlying this reexamination of America's basic national security strategy. Given two years warning of a Europe-centered global war with the USSR, the U.S. can **generate wholly new forces** -- to rebuild or *reconstitute* them if necessary. Current *surplus* forces will be disbanded, **not put into the reserves**, since the risk is deemed acceptable. Deterrence of aggression and coercion against the U.S. and its allies and friends will remain the cornerstone of American defense strategy.

Force levels supporting this new strategy were reported in the August 2, 1990 New York Times. The report, based upon leaks of a classified meeting in the White House and of the Defense Policy Resources Board, stated that the new *bottom line* levels of American forces could be 12 active, 6 ready reserve, and 2 *cadre* or reconstitutable reserve Army divisions

(currently 18 active and 10 reserve), 25 active & reserve tactical Air Force wings (currently 36), 11-12 aircraft carriers (currently 14), and 150,000 Marine Corps personnel (currently 196,000). Subsequent reports in the media and the higher force levels delivered to the Congress by the Administration in February may simply reflect budgetary *going-in* positions. These later reports include additional information: specifically 450 Navy ships (down from 538).

This new force structure was originally termed the "base force," by JCS Chairman, General Colin Powell. The force will be organized, for programming purposes, into four basic military components: Strategic nuclear offensive and defensive; Atlantic; Pacific; and Contingency Response Forces; and four supporting capabilities: Transportation, Space, Reconstitution, and R&D.

The Strategic Force includes offensive forces that will survive START-II, perhaps as low as 3000-4500 warheads for each side. In their February Congressional testimony, DoD Secretary Dick Cheney and General Powell outlined planned reductions and stated the Administration was prepared to cut strategic bombers from 268 to 181, stop OHIO SSBN construction at 18, terminate advanced Trident II (D-5) missiles retrofitting on all of those submarines, and that they now consider the MX rail garrison and small ICBM as strictly R&D programs.

With a reduction of the offensive threat to substantially lower numbers, it is not surprising that the Administration has also revisited the question of strategic defenses. Secretary Cheney outlined a reorientation of SDI, in his February 1991 testimony to Congress and subsequent written report to Congress, to a system of Global Protection Against Limited strikes (GPALS) -- indicating that it might have to be space, ground, and sea based. It is likely that strategic defenses will at least continue as an R&D program.

The Atlantic Force would be responsible for Europe, the Middle East, and Southwest Asia. It will include residual forces remaining in Europe and those forward-deployed to Europe (perhaps 100-125,000). The residual forces retained in Europe would consist of a heavy Army component (perhaps a Corps) with supporting air forces. In his December AFCEA remarks, General Powell stated that forward presence for the Atlantic Force means Marines in the Mediterranean, strong maritime forces, access in the Middle East, interoperablilty with allies,

flexible C^3 systems, and military assistance programs.

Atlantic Force forward presence will be backed up by a powerful and rapid reinforcement capability. General Powell also stated that Atlantic Force reinforcement and sustaining forces would include a mix of active and reserve heavy Army divisions and tactical fighter aircraft. The Chairman of the JCS stated that reinforcement also means the ability to project naval power and the Marine Corps across the ocean. In his testimony to Congress in February, General Powell stated that the Atlantic Force amphibious capability should include forced entry operations.

The Pacific Force will include a modest and chiefly maritime residual forward-based and forward-deployed force remaining in Korea, Japan and elsewhere in the theater, and reinforcing forces located in the continental U.S. General Powell has stated that "Compared to the Atlantic Force, the Reserve components maintained for the Pacific Force will be much, much smaller." It is unlikely that a modest-sized Pacific Force would have a dual commitment to the European theater in a revitalized *swing strategy*.

Perhaps the most dramatic innovation of the Chairman's recommended force structure is the creation of a CONUS-based Contingency Force -- responsible for Latin America and Africa, not the Middle East or Southwest Asia. This force will be shaped by the need to provide an overseas presence and response to regional contingencies -- not to return quickly to Europe.

Air Force General Butler, formerly the Director of Plans for the JCS, provided the following detailed breakdown of the Contingency Force when he spoke in September at the National Press Club. The first stage of a Contingency Force to be used in what he termed a "graduated deterrence response," for program planning purposes, would consist of (in the order stated): (1) Army light & airborne divisions, (2) Marine Corps Expeditionary Brigades (MEBs), (3) Special Operations Forces (SOF), and (4) selected Air Force units. At his AFCEA speech, General Powell placed Air Force and Navy units second, the Marines third, and SOF last. According to General Butler, this initial component of the Contingency Force would be buttressed as necessary by a second tier: carrier and amphibious forces.

The final tier of the Contingency Force appears to be heavier forces with the capability for long-term sustainability. We have seen this application in Operation DESERT SHIELD. General Powell added in his December RUSI and AFCEA speeches that the Contingency Force would have a very small Reserve component. He stated at AFCEA that the Contingency Force ". . . would draw as necessary from other larger Forces if it needed additional staying power and sustaining power." There seems to be some disagreement with the Army over this issue.

Ground units would fly to a future crisis, much as forces assigned to Operation DESERT SHIELD did. Sealift capability disclosed during this crisis will be studied and may result in new requirements and supplemental assets tailored for contingency response rather than the orthodox North Atlantic and NATO scenarios. The U.S. already has many such assets but may learn from recent experience that modest increments of additional sealift or prepositioned equipment are required. U.S. forces for crisis response appear to emphasize versatility, lethality, global deployability, and rapid responsiveness.

According to General Powell, transportation is one of the four major supporting components to the new strategy. The U.S. will certainly have to set aside sufficient lift to support immediate contingency operations by either the Atlantic or the Contingency Forces. DoD lift requirement will probably include the capability to handle concurrent operations but it is unlikely that funding will be provided by Congress for simultaneous crises given the years of deficiencies in funding lift for a 1 1/2 war strategy. Lift requirements for the Pacific Force are less clear.

Air and sealift for a major NATO war in Europe would be put into the type of forces that could be reconstituted during the two years that future program planning now assumes is available. Reconstitution of lift should include that provided by allies, charters from foreign non-aligned sources, and the activation of stored assets.

According to Secretary Cheney's February Congressional testimony, the U.S. will also formulate a peacetime strategy to deter low intensity conflict. Such efforts can be accomplished primarily by security assistance programs as well as other instruments of U.S. national power. In his testimony, General

Powell defined these other instruments of U.S. national power: stationed forces, rotational deployments, access and storage agreements, combined exercises, security and humanitarian assistance, port visits and military-to-military relations.

From this cursory initial look at the Chairman's base force and the strategic assumptions apparently approved by the President, it appears that the U.S. Navy will change the least, although it is very likely that some programs for new weapons systems are in jeopardy.

U.S. forces in Europe, and elsewhere, cannot be changed without considering commitments made to allies. While the United States is considering major changes in strategy and forces, so is NATO. The July 1990 NATO London Declaration stated that "NATO will rely more heavily on the ability to build up larger forces if and when they might be needed." The declaration stated that the Alliance too was preparing a new "military strategy moving away from 'forward defense' . . . towards a reduced forward presence . . ." It also stated that "NATO will field smaller and restructured active forces" and "will scale back the readiness of active units, reducing training requirements and the number of exercises."

Many nations are undertaking unilateral force reductions prior to NATO reaching an alliance-wide agreement on force structure. Germany is reducing its forces to 370,000 personnel with about half of that to be placed in the reserves. France is withdrawing all its officers and men from Germany. The U.K. announced a plan to reduce the British Army on the Rhine by about 50%. According to General John R. Galvin, SACEUR's realistic residual U.S. force for Europe apparently are one corps, several Air Force wings, and the Sixth Fleet.

The issues raised in the President's Aspen speech are numerous, complex, and require discussion. Some of the more important include: how likely is the new strategy to take hold; what is the lasting impact of Operations DESERT SHIELD and DESERT STORM; what are the new requirements for personnel and organizations, programming and war planning, the intelligence community, decision-making, investment strategy and technology; and the transition period?

The new strategic concepts unveiled by President Bush's speech are, however, a vision to be debated -- not an announcement of firm new governmental policy. Before any new

initiative becomes a funded government policy, vested domestic interests and America's allies will have opportunities to make their desires known.

After reading DESERT SHIELD and DESERT STORM after-action reports, analysts will try to determine what systems appeared to make a difference in the political and military outcome. Effective use of the PATRIOT anti-missile system is one that has already suggested to many the value of ABM systems for CONUS. Systems that did not make a major contribution to Operation DESERT SHIELD and DESERT STORM will need to be reevaluated for upgrading or cancellation and replacement. Under the new strategy to reconstitute capabilities useful in a Europe-centered global war with the USSR, there will be no need to retain systems that do not have a dual use in the Contingency Force.

A review of Service roles and missions will occur, no matter how painful, implicitly with budget decisions or explicitly if we dare. Do we need warfighting C-in-Cs for the entire world if the U.S. stops playing world policeman? Do we need the current number and geographical disposition for C-in-Cs? If the Operation DESERT STORM air campaign is not considered to be decisive, should we revisit the decision to have a separate Air Force? Does the U.S. need a separate Marine Corps or do we instead field a contingency response force made up of multiple services operating under joint military strategies? Should new services be created -- such as strategic nuclear, space, or SOFs? Should SACEUR automatically be an American or the Commander-in-Chief, U.S. Forces, Atlantic (USCINCLANT) automatically be a naval officer? These questions will all be debated.

Unquestionably, there will be a fundamental restructuring of the near-term programming already contracted, and there may be extraordinarily high penalties paid as industries move from the defense area to others. Programs such as the B-2, A-12, and other advanced technology aircraft, and programs tied to NATO's FOFA concept would appear related to an international security environment that no longer exists. There will be last-ditch attempts to salvage certain programs, to keep people employed, and legislative districts satisfied, and this will be a great challenge to the new Congress -- which should play its larger role instead of narrow constituent interests.

Some programming planning appears to have gone along, during 1990, without any clear recognition that the world has changed. There are signs that at least some parts of the Navy have recognized the changes and are worried about the implications for programming. SECNAV told Congress in February that we will reexamine the top priority emphasis formerly placed upon ASW to counter Soviet submarines. The U.S. Navy will face an extremely difficult task over retaining the SSN-21 SEAWOLF program in the new international security environment. Since it currently is the **only** submarine shipbuilding program (OHIO class ballistic missile submarines are considered national systems and exist quite apart from attack submarines), attempts to cut the SSN-21 will be interpreted as an attempt to cut the submarine force. It also seems obvious that the question of diesel-electric submarine shipbuilding in the U.S. will once again rear its head.

A central implication of the two-year war warning of a Europe-centered global war with the USSR is that American programming strategy will shift its attention to the dangers presented in other areas of the world. Until now, the unstated relationship of the threat to programmed forces was, generally, that U.S. forces would meet the challenge of the most demanding peril, the USSR, and assume that they could also cope with lesser contingencies. That basic assumption was generally not entirely true and now will be essentially reversed; forces will be acquired to meet the challenges of the more likely, less demanding threats, assuming that they are useful against the more unlikely but greater threat posed by a Soviet Union that decides to rearm.

For the submarine community, this means that the goal of 100 SSNs, previously justified assuming a European-centered global war with the USSR, must find new rationalization. From the programming documents released in early March, it seems that we are headed toward an overall force structure and OPTEMPO that will support the ability of the U.S military to respond to 1 or 1 1/2 contingencies with active-duty forces. The CNO told Congress in February that with a 450-ship Navy and a 30% deployment rate, we could sustain 14 SSNs on forward deployment and could respond to any crisis with 2 CVBGs and a MEB. It would take a 40% deployment rate to be able to respond to regional conflict with 3 CVBGs and a full MEF; but

rates in excess of this to have a carrier available for simultaneous response in another theater. Certainly the submarine community will have to answer those that question whether we need 14 SSNs at sea in our new crisis response-heavy strategy if we are only going to have the capability to respond with two carrier battle groups and a MEB.

New justification for the submarine force might include both substituting for carriers called away for crisis response and direct integrated response in crisis areas performing surveillance, power projection, delivery of special forces, combat SAR, evacuation of nationals or hostages, blockade interdiction of surface traffic, etc. Rationalization for SSNs also involves GPALS since submarines are high leverage platforms that can carry ICBM/SLBM interceptors which can catch missiles in the boost phase of flight. Perhaps we should consider ready reserve submarines. Using these and other more traditional missions, the submarine force can justify some total number of hulls that it needs before it proceeds to the specific types to be built. The CNO's 30% deployment rate means that he used around 50 available submarines in order to achieve 14 subs routinely on deployment.

As for the type of submarines we will build in the future, the CNO told Congress that he has ordered studies to explore a new, lower cost option for a successor to the SEAWOLF. Since it would likely take 10-15 years to launch the first "SSN-X," we may see a maximum of some dozen or so SSN-21s built before a newer and less-capable class would be available.

Four main problem areas threaten success for the President's dream. The first is that everything depends upon the responsible and good behavior of the Soviet Union. It may not be desirable to have your fundamental national security strategy so dependent upon the behavior of the once *evil empire* but, for any of this to work, the Soviets must return to their homeland, remain inwardly focused, and continue the serious reductions in military capability they have started.

The second critical area demands that the intelligence community must be able to surmount the new challenges. If funding for intelligence follows defense downward, then the reconstitution portion of the new strategy is bankrupt. The intelligence community should move into spheres they have traditionally under-emphasized, such as the Third World and

economics. They will also have significantly increased burdens demanded by the monitoring and verification of compliance of arms control agreements. All of this is possible if decision-makers recognize this crucial underpinning of the new strategy and are prepared to make courageous decisions early.

The international behavior of allies and the U.S. Congress is the third area that can undermine a successful transition to this new world. None of this is going to happen without Congress onboard. Secretary Cheney's efforts to articulate the new strategy are designed to ensure that the Department of Defense is ahead of Congress and that the new policies are adopted.

A fourth critical success factor is the ability of private industry to deliver. What is envisaged is **not** the same as industrial mobilization. We need to both save our defense industrial base under **very** new conditions, **and** simultaneously reduce defense spending.

The President's new strategy is a **programming** concept that supports the continued reliance on deterrence or war as the cornerstone of American security. There are those who doubted that the U.S. would ever actually use centrally-based nuclear weapons for the defense of Europe -- perhaps a President never would have decided to actually do that. Deterrence strategies are influenced **greatly** by perceptions; under the new strategy, it will be important to maintain the perception of our ability to reconstitute. Just as in the past, programs, deployments, exercises, and literature evidence will need to be provided to support deterrence.

Major changes to the international environment have led planners to an uncustomary turnabout in the manner of addressing problems and issues. The first order questions, such as "what is America's role in the world, or the business and purpose of the DoD," now demand answers prior to consideration of second order programming or efficiency issues, that have dominated the traditional defense debate.

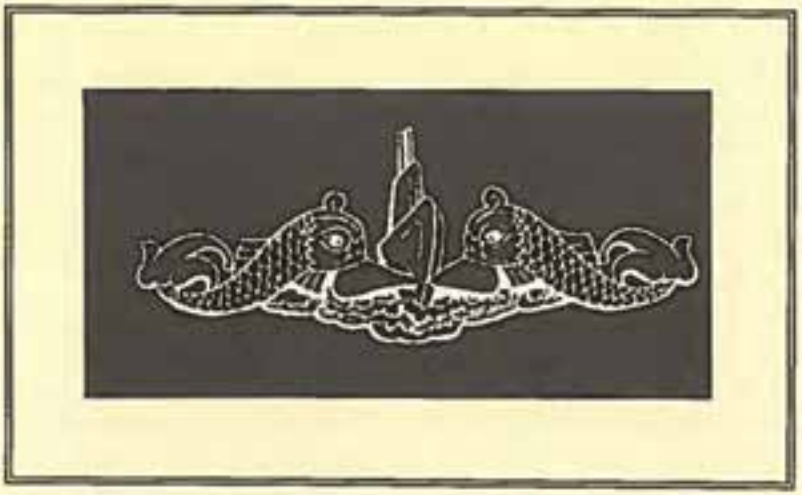
Much legislation will be required as a result of the changes in the international system -- this exercise is not going to occur only in the Executive Branch of government. The two government branches **can** cooperate or they can assume an adversarial relationship. Congress will cut forces and programs -- with or without a carefully thought out plan. The Administration must present all possible options for cuts to the legislature -- even

those that wrench the very souls of the leaders of a particular combat arm or military service. They appear to be prepared to meet this challenge.

Should the military Services refuse to present realistic plans for reductions to the DoD, or play end-around games with Congress, the cuts will be made anyway. The Services could find themselves playing catch-up, and redrafting strategies from whatever forces the resulting legislation permits. The looming debate should be about goals and objectives, realizing that they do **not** have to be what they were in the past. If we are realistic about these goals and objectives, there is every likelihood that we can reach a consensus on force requirements. If we engage in debate over force structure, instead, we will perhaps stumble into a strategy that will not serve the national interests in the 21st Century.

[Note: The views expressed by the author are his alone and do not necessarily represent the position of the U.S. government, Department of Defense, or the U.S. Navy. For a full treatment of this issue, see the author's "America Promises to Come Back: A New National Strategy," Naval Postgraduate School Technical Report NPS-NS-91-003, December 1990 - Updated February 17, 1991, 104 pp.]

■



INDUSTRIAL BASE

by Edward J. Campbell
President and Chief Executive Officer
Newport News Shipbuilding

At the outset of this examination of the shipbuilding industrial base let me quote two gentlemen who I admire very much -- Admiral Frank Kelso, the current Chief of Naval Operations, and Homer Ferguson, Chief Executive Officer of Newport News Shipbuilding from 1915 to 1946. These two quotes in combination hold the essence of what will follow here.

Admiral Kelso told a congressional committee recently, "We have entered an era where we may no longer have the industrial capacity to rebuild a fleet in time of crisis. We must maintain sufficient construction to provide a capable fleet over the long term."

Homer Ferguson, before another congressional committee some 56 years earlier, said, "A second best Navy is like a second best poker hand."

With a second best poker hand you might be able to bluff for awhile, but sooner or later you are going to lose. This country is holding a poker hand in the shipbuilding industry that we hope none will call. And, surprisingly, that hand was dealt during the Reagan Administration.

For most of its 105 year history, Newport News Shipbuilding built a mix of commercial and naval ships. This balance made it possible to bridge the dips in the commercial market and to survive the vagaries of an unpredictable defense budget. It maintained a talented and trained work force throughout even the lean years of the depression and the years following the Washington Naval Conference of 1921. This made it possible, for instance, to ramp up in a hurry to support the enormous shipbuilding effort in World War II. During World War II Newport News Shipbuilding was not only able to deliver an Essex Class aircraft carrier every six months, and produce other ships, but it was able to create an entirely new shipyard in Wilmington, NC to construct Liberty and C-2 ships. This is one of the many reasons President Roosevelt could call America the "Arsenal of Democracy."

Could the shipbuilding industry do that today?

As Admiral Kelso indicated in the quote above, it would be unlikely. Navy ships, particularly nuclear ships, with their attendant technology, testing and oversight procedures would inhibit that kind of rapid construction. Also, of course, the reduced number of shipyards that retain the capability to build Navy ships, and the limited number of domestic suppliers to the shipbuilding industry would make a fast ramp up, as happened in World War II, almost impossible. I would add one other point that reinforces what Admiral Kelso has said. The current acquisition environment and the uncertainty of government work make capital investment very risky indeed.

The foundation of the success of any military operation, and any company, is in its people and equipment. Our country's capability to build the appropriate types and amounts of equipment to win in war and to deter war has been one of our great strengths. We have seen this many times throughout our history which I need not elaborate here. I would only point out the most recent successes in the Cold War and in the Gulf.

Add to this the fact that this country is an island nation, heavily dependent on the seas as avenues of commerce, highways to our allies and trading partners, and for its protection, and you come to the indisputable conclusion that we need a strong Navy and maritime industry.

As the Reagan Administration began, there was great optimism in the shipbuilding industry because of its strong commitment to rebuilding the Navy. But, soon after that positive note, a discordant one reverberated throughout the industry. A policy decision was enacted eliminating subsidies in the American shipbuilding industry, making the United States the only country in the world shipbuilding market without such subsidies. Commercial customers for American shipyards soon disappeared, leaving the yards with only one customer, the U.S. Navy.

Some shipyards flourished during the 1980s and were able to invest in the future. Newport News Shipbuilding is one of those, putting almost a billion dollars into improved manufacturing facilities and computer capabilities over the decade. For instance, we built the most modern, state-of-the-art submarine modular construction facilities in the industry, and combined that with the most comprehensive computer capability in the industry. Our copyrighted three dimensional computer design

tool called VIVID is being used in the design of the SEA-WOLF Class and future submarine construction. But, for many other companies in the shipbuilding industry, the hand dealt in those years caused them to cash in or drop out.

Since 1982, 40 percent of the shipyards then identified as essential to our country's defense industrial base are no longer in the game. Over 50,000 shipyard production worker jobs have been lost. The talent represented by that loss is one of the hardest industry requirements to reestablish, and may be lost forever.

Today, only five U.S. shipyards build the majority of major ships for the Navy. We at Newport News feel fortunate to be among them. At one time there were six yards building aircraft carriers. Today, only Newport News Shipbuilding has that capability. More than a dozen shipyards built major surface combatants and today there are two. The situation is similar in submarines. At one time nine yards built submarines and seven of those built nuclear submarines. Today, there are only two -- Newport News Shipbuilding and Electric Boat.

At the same time, the supplier base, particularly the domestic suppliers, in the shipbuilding industry continues to shrink as we in industry, those in the Navy, Defense, Commerce and Transportation Departments and the Congress ponder and debate what can be done.

Newport News Shipbuilding is fortunate to still have an adequate base of suppliers for materials and components for submarines. These companies are located in 39 states across our country. However, this supplier base is dwindling. there are several reasons why.

Many of these firms have been suppliers to both the Navy and commercial shipbuilders. However, as mentioned before, there is now virtually no commercial shipbuilding being done in the United States. Additionally, suppliers of Navy ships must meet the unique military specification requirements that have special quality control and testing procedures. Without sufficient volume of work, and in the face of an uncertain market, suppliers are not willing to make the investments to support these requirements, and they leave the Navy supplier base.

Additionally, the volumes upon volumes of acquisition regulations and accounting procedures, coupled with often times

intrusive oversight methods used by government, create an environment that companies that do have a commercial option simply will not tolerate. They would just as soon bypass government business rather than submit their companies and employees to this kind of treatment.

Finally, but certainly not least, the defense market is unstable and suppliers have been leaving because of the uncertainty of future business levels.

Here are some examples of the supplier base erosion. There are now only three suppliers of the high quality steel used by Newport News Shipbuilding. The number of domestic plate mills have been reduced from 10 to 4 and the number of shape mills from 7 to 2 in just the past ten years.

In recent years, four companies have left the pipe supplier market and since 1975, over 60% of the companies making pipe fittings have ceased operations. Both are key commodities.

Another critical commodity is valves. Yet, over the past five years seven companies have ceased supplying submarine valves. Loss of a valve manufacturer is expensive because of the designed-in proprietary nature of the product. Enticing new suppliers to pick up the requirements is difficult, given the limited application and uncertain future of naval contracting.

Navy News and Undersea Technology quotes one analyst as saying, "A lot of vendors are in the hand-to-mouth situation. Between now and 1997, you will see the disappearance of many vendors which support the shipyards. A substantial contraction is expected ... A lot of these vendors are specific to the Navy and specific to the nuclear submarine program especially." This, of course, has to be a concern for the SEAWOLF program, considering the reduced rate of SEAWOLF construction in the current budget. We were disappointed to see that the construction rate had been reduced once again from the decision taken last year, the third such cut in three years.

SEAWOLF represents a significant advance in technology over previous submarine designs. And, much of the burden for developing these new designs has fallen on the submarine supplier base. As I wrote earlier, while the submarine supplier base is adequate now, the near future is a real question mark. The five year future forecast is not a question; it is certain to go down.

In recent weeks there has been much discussion about whether there will be one or two shipyards building the SEAWOLF Class submarine. It is very clear that it is in the best interests of this nation and the Navy, that both current submarine builders retain the capability and the work force to build nuclear submarines. If this country believes it will need a submarine force in the future, and I believe it will, then the reduction to one shipyard in that business would be tantamount to a threat to national security.

Leading naval sources forecast a 25% reduction in the number of overall suppliers by the turn of the century without some intervention in the marketplace. As American shipbuilders and their supplier base move into the 1990s, the key word seems to be uncertainty. With a reduction in the defense budget and an uncertain commercial market in the future, there is no other word that is more apt.

Some things that could help are:

- a philosophical change in the approach to acquisition by DoD to make the market more attractive to suppliers, such as higher progress payments, lower retentions, less oversight, etc.
- a sealift building program to enliven the shipbuilding base, and to fill a definite need, since foreign flag chartered ships made up the majority of cargo transports to the Gulf War.
- a continuation of the fair-trade efforts for worldwide shipbuilding.

I would hope that the hand dealt to the U.S. maritime industry in this decade would be strong so that our great country will retain a predominant naval strength, and again achieve the kind of maritime stature for which we nave been noted in the past.

A small box came to me in the mail recently. Inside the box was a fortune cookie in a plastic bag wrapped in paper. Printed on the classic small piece of paper inside the fortune cookie was "Facts do not cease to exist by ignoring them." That is clearly something all of us who have a stake in the future of shipbuilding and our country need to remember.

■

MAINTAINING THE U.S. SUBMARINE INDUSTRIAL BASE

by James E. Turner, Jr.
Executive Vice President
Marine, Land Systems and Services
General Dynamics Corporation

The U.S. submarine force represents the most versatile and capable weapons system in the nation's defensive arsenal. Silent, elusive and packing a formidable punch, submarines are unlike and unmatched by any other weapons platform produced.

As defense spending contracts in response to still emerging world political realities, it becomes even more crucial that the country continue its investment in the submarine fleet as the most cost-effective weapons system now employed in support of national strategies.

There is no doubt that U.S. submarines are second to none. The effort required to maintain their superiority and successfully counter evolving threats translates into the need to preserve the country's submarine industrial base. This unique and highly specialized base, which supports the technology needed to design, build, repair and provide lifecycle support for the Navy's submarines around the world, is a national strategic asset.

The industrial base marshalled to produce the 688-class and TRIDENT-class ballistic-missile submarines represents one of the most highly specialized and technical industries in the nation. For the next several years, this base will depend solely on the SEAWOLF class, making it imperative that the acquisition strategy employed for this program is effective in maintaining our capabilities now and in the future.

Initially, the SEAWOLF program called for the procurement of a nominal force level of 30 submarines at a construction rate of three to four per year, a level that would support competition between Electric Boat and Newport News Shipbuilding, the nation's two nuclear-capable shipyards. That plan changed dramatically during 1990; it now appears that the class will be limited to 12 ships at a procurement rate of one per year at least through 1995.

This low rate of production does not lend itself to traditional competitive procurement procedures. An alternative acquisition strategy must be developed to maintain the key elements of the

submarine industrial base, including nuclear propulsion engineering, facilities, trades and vendors.

The dilemma that arises is as obvious as it is knotty -- how do we protect this vital industrial base in an environment marked by sharply reduced defense spending.

Over the long term, this issue will be addressed by the introduction of a lower-cost SSN, described recently by CNO Admiral Frank B. Kelso, II. With a lower unit cost, this new class could be procured at rates high enough to support the operation of two submarine shipyards. The new class would also enable the Navy to maintain its desired force levels beyond the year 2000 when large numbers of 688-class submarines are scheduled for retirement.

In the meantime, the health and welfare of the submarine industrial base remains tied directly to the fate of the SEAWOLF program, which is, in turn, linked to the cost-effectiveness of its acquisition strategy. Boiled down to basics, the production of the SSN-21 class in the most cost-effective manner represents the best possible way to positively influence the program's scope and duration.

The key element in a cost-effective acquisition strategy for SEAWOLF is to establish a stable production rate at one supplier to drive costs out of the program. The second supplier should be introduced when production rates and budgets support.

The benefits derived from a stable and predictable workload are perhaps best illustrated by the Navy's TRIDENT ballistic-missile submarine program. Widely praised as one of the most cost-effective weapon systems procurements in U.S. history, the success of the TRIDENT program results primarily from the maintenance of a consistent procurement rate. This approach brought both the Navy and Electric Boat significant cost savings based on the ability to level-load the work force, as well as the buildup of a large and competitive supplier base. The program has been responsible for delivering the last 10 of the TRIDENT class ships an average of 6.8 weeks ahead of schedule. Over the course of this program, quality has improved at an annual rate of more than 10 percent.

In the case of the SEAWOLF program as it now exists -- with two shipyards vying for a single submarine contract per year -- there is virtually no possibility of maintaining a stable

and predictable work load. In fact, there is a distinct likelihood that Electric Boat may be forced out of business if it is not sustained at a one-ship-per-year rate.

As a hedge against this scenario, Electric Boat has investigated several avenues of diversification, including submarine overhauls, construction relating to the commercial nuclear power industry, and commercial and naval surface ships.

None of these opportunities, however, could be expected to sustain either the work force or facilities currently in place at Electric Boat, which is dedicated exclusively to nuclear-submarine construction.

To maintain an industrial base of two nuclear-capable shipyards, and to achieve the lowest possible cost, it is clearly preferable to direct SEAWOLF construction to the yard that specializes exclusively in submarine design and production. With its greater market flexibility, the second shipyard could, in the meantime, rely on its broader capabilities until SEAWOLF procurement levels reach a point where it could be brought in to help build the Class. This approach would also avoid the risk of forcing the lead SEAWOLF construction yard out of business.

A cost-effective strategy for the SEAWOLF program must emphasize production stability, which will promote the best use of the capabilities developed by the industrial base.

Many of these capabilities -- particularly modular construction and outfitting -- were developed and proven by Electric Boat and are demonstrated daily in its operations. EB's Land Level Submarine Construction Facility at the Groton, Connecticut shipyard, has operated smoothly since 1974, acting as a forerunner of other domestic and United Kingdom land level facilities. Designed to handle, move and assemble heavily outfitted submarine hull sections into complete submarines, it has enabled Electric Boat to pioneer and continuously improve labor- and time-saving modular submarine construction techniques.

Another capability crucial to the maintenance of the submarine industrial base is Electric Boat's 4,500-person engineering and design staff, which is closely involved in all facets of undersea technology including propulsion, combat systems, acoustics, hydrodynamics and advanced materials.

The facilities and engineering capabilities in the industrial base represent a breadth and depth of knowledge, skill and experience that cannot be simply switched off and back on again, except at exorbitant cost. A shutdown of Electric Boat would be, in all likelihood, irreversible and bring with it irretrievable harm to the industrial base.

The work force is another critical part of the defense industrial base, an element that is in place, that has already been paid for, and that cannot easily be replaced or reactivated. This team cannot be put in storage or mothballed -- it must keep working to remain effective.

EB's own history demonstrates that a high percentage of skilled trades people do not respond to job recalls. Many of them find other jobs, while residual uncertainty about long-range employment prospects makes it difficult to attract and retain new workers. Top performers migrate to outside job opportunities, while the disruption of work crews can lead to schedule and budget overruns.

At a construction rate of less than one ship per year, the future of Electric Boat is jeopardized. Not only is the closing of the division's manufacturing sites probable in this scenario, but the cost of all ships now under construction could also be affected.

The ripple effect of a shutdown would be devastating and widespread, placing at risk the higher technology sector of the overall submarine industrial base. This sector, the supplier of specialized technology needed to build and maintain the submarine fleet, employs tens of thousands of skilled employees at a shrinking number of subcontractor and supplier firms.

The decline in recent years of industries that used to share elements of a common base -- surface warship and commercial shipbuilding, commercial nuclear power, and offshore oil, for instance -- has already reduced the manpower and technology pool available.

The submarine industrial base is a national asset with a replacement cost beyond the reach of business or government. Its continued viability is necessary for the preservation of the high-technology capabilities that will be required in the 21st century.

Again, the vital element that will lead to the preservation of these key capabilities is a stable production rate and a cost-

effective acquisition strategy for the SEAWOLF. This should be the goal for all of us -- Navy, contractors, employees and suppliers -- in the difficult period ahead.

■

THE SUBMARINE REVIEW

THE SUBMARINE REVIEW is a quarterly publication of the Submarine League. It is a forum for discussion of submarine matters. Not only are the ideas of its members to be reflected in the REVIEW, but those of others as well, who are interested in submarines and submarining.

Articles for this publication will be accepted on any subject closely related to submarine matters. Their length should be a maximum of about 2500 words. The content of articles is of first importance in their selection for the REVIEW. Editing of articles for clarity may be necessary, since important ideas should be readily understood by the readers of the REVIEW.

A stipend of up to $200.00 will be paid for each major article published. Annually, three articles are selected for special recognition and an honorarium of up to $400.00 will be awarded to the authors.

The views expressed by the authors are their own and are not to be construed to be those of the Naval Submarine League. In those instances where the NSL has taken and published an official position or view, specific reference to that fact will accompany the article.

Articles should be submitted to the Editor, SUBMARINE REVIEW, P.O. Box 1146, Annandale, VA 22003.

Comments on articles and brief discussion items are welcomed to make the SUBMARINE REVIEW a dynamic reflection of the League's interest in submarines. The success of this magazine is up to those persons who have such a dedicated interest in submarines that they want to keep alive the submarine past, help with present submarine problems and be influential in guiding the future of submarines in the U.S. Navy.

■

INDUSTRIAL BASE FOR SUBMARINE COMBAT SYSTEMS

by Daniel A. Curran

A special segment of American industry has supported the building of nuclear submarines since the NAUTILUS in 1952. There has been a lot of attention in the press about the shipyard industrial base since there are only two shipyards -- Electric Boat and Newport News -- who are presently qualified to build nuclear submarines. But there has been little written about the industrial base for submarine combat systems. Of the total cost of approximately two billion dollars for a SEAWOLF (SSN-21) for example, roughly 700 million dollars passes through the hands of the shipbuilder and his subcontractors and about a quarter of a billion dollars is applied to the combat system for both industry and government support. The rest pays for the reactor and other government furnished equipment. Like the shipyards, this industrial base builds unique equipment with few outlets other than U.S. nuclear submarines. The decline in the defense budget will affect these companies and the questions are: whether the country can sustain the ability to produce submarine combat systems in the coming years and what might we do to maintain the continuity of the work done over the last thirty-five years? First we should define what we mean by submarine combat systems and the industrial base and then identify some steps that might be taken to revitalize the base and preserve this national asset.

Submarine combat systems are those components, equipment and computer software, of the command and control, sensors, fire control and weapons that enable the submarine to carry out its military mission. Also included are the spare parts, the trainers and training, and other logistics support items. This paper does not address strategic weapons systems although the same problem exists for the TRIDENT weapon system.

Each of the various submarine combat control configurations consists of a sonar suite, a mass memory, a main frame computer, navigation equipment, signal data converters, fire control software, weapons and additional displays with their mass memory and computers. The Fire Control Systems, MK 117 and 118, the Combat Control System MK 1, the AN/BSY-1 sonar, and the improvements to those systems which are under

development, like Combat Control System MK 2 and the AN/BSY-2, are among the combat systems and combat control systems aboard or planned for the STURGEON (SSN-637), the LOS ANGELES (SSN-688), the SEAWOLF (SSN-21), and the TRIDENT classes. Combat systems and nuclear propulsion plants are government furnished (GFE) to the shipyards and represent a significant percentage of the cost of the total submarine. The combat systems are now more expensive than the reactor so we are considering a sizeable market.

The industrial base includes several large companies and hundreds of large and small subcontractors. The Navy laboratories and the in-service support agencies represent another large part of the support base for submarine combat equipment but are not normally counted as part of the industrial base.

The United States industrial base for submarine combat systems reads like a who's who of Fortune 500 companies. Companies like AT&T, G.E., General Dynamics, Hughes, IBM, Martin Marietta, McDonnell-Douglas, Raytheon, Unisys, and Westinghouse and hundreds of subcontractors and vendors produce or have produced most of the hardware and computer software for the submarine weapons, fire control, sonars, and command and control equipment deployed today. None of these companies is wholly dependent on combat system work but each company has a sizeable group of professionals devoted to the business. Some of these companies have been involved in the Anti-Submarine Warfare (ASW) business since the First World War.

Submarine Signal Company (Raytheon), General Electric (GE), and Western Electric (AT&T), along with a government laboratory then located in New London, Connecticut, formed a consortium in 1917 located at Nahant, Massachusetts, to build and test the first military sonars. This WWI laboratory in New London was the predecessor of the Acoustic Section of the Naval Research Laboratory, not as one might think, the Naval Underwater Systems Center. The Naval Underwater Systems Center has its precedents in the Harvard Underwater Sound and Columbia University Laboratories of World War II and the U.S. Torpedo Station at Newport, Rhode Island (itself dating back to the nineteenth century). Others like Westinghouse and Martin Marietta (Chesapeake Instruments) are pioneers in modern torpedoes and towed sonar arrays. All of these

businesses and their large subcontractor base along with companies like EDO and Librascope have the capability to design, produce, and support components of the entire submarine combat configurations. Their major customer for the submarine business, however, is the U.S. Navy.

The submarine combat system business like the submarine hull, machinery, and electrical business is dependent on the number of U.S. ships built or retrofitted per year plus the research and development devoted to improvements to the existing classes or to the next class of U.S. submarines. There has been very little international outlet for U.S. submarine products. The number of submarines and the research and development goals are dictated by the U.S. national maritime strategy, the threat and those tactical and strategic missions assigned to the Submarine Force.

The dramatic change in the Cold War with the Soviet Union and the unleashing of other forces within the dynamics of the world political situation like the Persian Gulf Crisis have called into question in some minds the priority of Anti-Submarine Warfare (ASW) and the submarine as the main ASW platform. What effect can we expect on the industrial base for submarine combat systems in this environment?

The arithmetic is simple. The end of the SSN 688 and TRIDENT programs and any decline in numbers of SSN-21 submarines will cause a dramatic decline in the industrial base for submarine combat systems, probably greater than the 31 percent decline in constant 1991 dollars for military electronics over the next decade projected by a recent Electronic Industries Association (EIA) report. The submarine industrial community will shrink as the building rate drops from three attack submarines plus a TRIDENT to 1.5 submarines or less a year. This is greater than a 60 percent decline.

In fiscal year 1989 the submarine combat system production and R&D budget was approximately $1,800M in FY'91 dollars. In fiscal year 1992 the submitted budget is about $1,220M and $1,022M for fiscal year 1993 in FY'91 constant dollars. The trend predicted by the EIA report is starting to happen.

Logic would dictate that we can preserve the industrial base by any one of six factors or any combination thereof.

- First, build more submarines of the type we now have, SSN 688, SSN-21, or TRIDENT;
- Second, make major improvements to the submarines we now have to match new missions and threat capabilities;
- Third, design and build a new smaller submarine to be produced in larger numbers;
- Fourth, find an outlet for the submarine products in other U.S. ASW or commercial markets;
- Fifth, reduce the cost of our submarines including the combat systems so we can afford more numbers; and/or
- Sixth, sell our submarine equipment or versions thereof to the international market effectively competing with the British, French, and German companies who currently dominate that marketplace.

There are problems associated with each solution so in reverse order we will examine each factor.

The international market for submarine systems, a potential outlet for U.S. products, has been essentially closed to the submarine combat systems industry for many years because of the technology transfer regulations, principally the International Traffic in Arms Regulations (ITAR), a ban on building diesel submarine hulls for export and the general feeling in the submarine community that no U.S. submarine equipment should be exported that might give any other country the capability of detecting U.S. submarines. In contrast, the submarine combat system industries in the United Kingdom, France and Germany, faced with their own market decline but with lesser restrictions, have begun to aggressively sell their products to the outside market with support from their respective governments. Their products are suited to the mid and small size submarine hulls while our combat systems have grown to accommodate larger and larger hulls. This brings up the factor of the cost of our products.

The cost in constant dollars per pound of our submarines has not changed much over the years. What has happened is our submarines have grown larger and the combat systems have grown even more, primarily to match the significantly quieter threat. As mentioned above, the cost of the combat system is now a significant percentage of the total submarine cost. This trend influences another factor; applicability to other U.S. markets.

It has been difficult but necessary for the submarine combat system industry to shift to other U.S. ASW markets because the submarine equipment specifications have made the components generally heavier due to shock hardening and more expensive than those used in the surface, air and surveillance ASW communities. Several of the companies have diversified but this is an expensive proposition which takes several years. The commercial sonar market world wide is now dominated by the Japanese because of U.S. technology transfer issues. Although a few U.S. commercial companies have succeeded in the commercial market, they have stayed away from the military side of the business and are not therefore part of the combat system industrial base. Another major reason for non-applicability to commercial products is that the computer software portion of the modern submarine combat system has risen to over 50 percent of the cost of development, production and support. Most of the software product is not transferable to other countries for military products and has little use in the commercial market.

We are now led back to building a new submarine which can take 10 to 12 years to design and produce the lead ship (but studies show that overall the design, development, and production of a smaller submarine will cost just as much or more as we would have spent on the full production run of the larger SSN-21 submarine); to making improvements, like the CCS MK 2, to our existing submarines (however, no money has been planned for mission upgrade improvements other than the AN/BQQ-5E and the CCS MK 2 and new missions have not been defined); to building more of the same which appears to be politically impractical. So what can we do to preserve the submarine combat system industrial base?

- First, we should recognize that nuclear attack submarines and their combat systems are vital to protecting our TRIDENT fleet. The Soviet intercontinental ballistic missiles pose the only serious threat to our national security. The TRIDENT fleet with over sixty percent of the U.S. strategic missiles provides the counter to the Soviet threat.
- Second, we should recognize that research and production are equal partners in the industrial base. Development alone or with limited prototype production cannot sustain

the base. Research without production is the blueprint for a *going out of business plan* for the industrial sector.

- Third, the development cycle has grown so long and burdensome and the systems have grown so large that innovative ideas are effectively shut out of the R&D pipeline.
- Fourth, there are larger world markets in which the industry should be permitted to compete.

The submarine combat system industrial base is vital to our national security; therefore, the U.S. Navy and industry in partnership, with organizations like the Submarine League, should address head-on the problems discussed. The trends and paradigms of the submarine combat system business should be reexamined and reversed in some cases to preserve the national asset called submarine combat systems industrial base. ■

IN REMEMBRANCE

Captain Gary F. Velat, MC, USN

Herbert Davey Thornton

Carl Hartdegen, III
WW II Submariner, and Charter Member of
NSL Central Florida Chapter

SUBMARINE WARFARE AS AN INSTRUMENT OF POLICY

by Richard P. Hansen

The submarine has presented the potential of being a decisive weapon for the country bold enough to seize its potential throughout the twentieth century. Since World War I, submarines have accounted for 10,000 ships destroyed -- approximately 80 percent of all combat-related sinkings -- totalling 40 million tons. The effectiveness of submarine warfare has caused nations to attempt to control submarine operations, construction, and weapons loadout to forestall the effect a well trained and properly directed submarine force can have. Attempts to restrict wartime submarine operations early in a conflict, by the nation having the initial edge in submarine technology and force capabilities; however, have led to wasted opportunities to play an important -- if not decisive role -- in a conflict's outcome.

The submarine was an unknown quantity prior to the First World War, although fear of underwater weapons dated back to the 18th century with the TURTLE's attack on HMS EAGLE.

Few naval leaders -- let alone policymakers -- saw the submarine as the effective commerce raider, warship destroyer, or shaper of policy it was to become in the First World War. The consensus was that commerce raiding -- the future focus of the submarine's mission during two global conflicts -- would be conducted along traditional lines and in accordance with international laws. Merchantmen would be stopped, searched for contraband, and if the ship was taken, the crew sent to lifeboats prior to destruction. A small minority saw the submarine's potential in *guerre de course* warfare. Any concerns could be summed by Winston Churchill in 1913 when he stated, "Of the greatest question (in the next conflict) is the use of submarines to sink merchant vessels, (but) I do not believe that this would ever be done by a civilized power."

German submarine operations at the beginning of World War I appeared to validate judgments that the submarine would not play a major role. Although the German submarine force had some successes in 1914 such as the sinking of the ABOUKIR, HOGUE, and CRESSY in less than an hour, submarines had little impact on the war at sea or on policy

ashore. Existing prize rules and procedures for search and seizure made submarine warfare a very inefficient means of commerce raiding. The Royal Navy maintained command of the sea, English merchantmen facilitated England's long supply lines to its empire, and Germany was effectively blockaded by British control of the North Sea.

The stalemate on the Western Front in 1915 motivated Germany to change its position on submarine warfare. Trench warfare made a military breakthrough on land seem unlikely. The German Navy looked at the submarine as an alternate military means to challenge British superiority at sea and react to the blockade of German ports. Following Britain's declaring the entire North Sea a war zone, Admiral von Tirpitz advocated an unrestricted U-boat campaign against Britain's seaborne trade and commerce.

The decision to conduct an unrestricted submarine campaign had important policy implications. All Allied merchant ships would be destroyed, but neutral ships had to be put at risk because of the British practice of using false flags to protect its shipping. This forced Berlin to carefully weigh the military advantages of an unrestricted submarine warfare campaign against the potential of the United States entering the war as a result of U-Boat sinkings. After careful consideration, the Germans chose to escalate the war against seaborne commerce in March 1915 using a clearly defined, publicly announced war zone around England and Ireland, coupled with official warnings in the press of potential hazards.

The political impact of the first U-boat campaign; however, was highly negative in shaping German-American relations. The sinking of the passenger liner LUSITANIA in May 1915 with the loss of 125 American lives was followed in August by the loss of American life on the British steamer ARABIC. These incidents resulted in strong U.S. diplomatic and political protests -- sufficient for Berlin to believe the United States might declare war. Strong protests from Washington convinced the Germans that maintaining a neutral United States, for the time being, outweighed any success the U-boats gained at sea. In a move to placate washington, Berlin placed liners off limits and shifted their U-boats to the Mediterranean -- away from American shipping. Nevertheless, Berlin's actions had little affect in erasing the American perception that Germany was

fighting from a lower moral position than Great Britain and the Allies.

Initial U-boat efforts at cutting the Allied sea lines of communications were hindered because the Germans did not have sufficient U-boats available to conduct an effective campaign. At the outset of the 1915 campaign, the German Navy could only call on about twenty U-boats, or one tenth the number called for in a staff study to accomplish its mission.

Successes from the 1915 U-boat operations, however, gave the German Navy confidence in the capability of the U-boat service to cut England's supply lines. The German Naval Staff in 1916 again called for a continuous economic war to be waged by submarines, using every available means and without restrictions that would cripple U-boat effectiveness. Led by Tirpitz, the naval staff believed that based on previous experience British resistance could be broken after six months by unrestricted submarine operations.

Berlin still was not ready to make full use of the submarine as a weapon because it feared the possible entry into the conflict by United States. The Kaiser ordered that submarine attacks without warning be made only on armed merchantmen within the German War Zone. Nevertheless, the U-boat campaign fueled British propaganda efforts and was providing motivation for the United States to officially join the Allies. In 1916, the French steamer SUSSEX was torpedoed with three Americans injured. Washington strongly protested the attack and threatened to break diplomatic relations. To defuse the situation, Berlin announced its "SUSSEX Pledge". The pledge guaranteed that Germany would conduct submarine warfare in accordance with established prize laws and, with the subsequent resignation of Tirpitz, U-boats were shifted to attacking warships.

Inconsistencies and lack of focus greatly hindered the anti-commerce campaign's military effectiveness. Total unrestricted submarine warfare was contemplated by Berlin only as a last resort when the German government came to the realization in late 1916 that they were no closer to victory than in 1914 and were engaged in a losing war of attrition. After the indecisive Battle of Jutland, German leaders again saw the submarine as the one naval weapon that had the potential to turn the tide in their favor.

In a key policy act, Berlin announced renewed unrestricted submarine warfare in February 1917 and abrogated the 1916 SUSSEX Pledge. German-American relations quickly deteriorated, with Congress declaring war in April 1917. Although this final U-boat campaign was not successful in bringing the British to their knees, it came dangerously close to succeeding. The final statistics show the Germans sank 5,234 ships totaling 12,185,832 tons of shipping, but peak losses only occurred in 1917 when the Germans fully committed themselves to an unrestricted submarine campaign.

The effectiveness of the German Submarine campaign was not lost on the Allies at the end of the war. In essence, the Allies forced on Germany a *zero option* form of arms control. The Peace Treaty stipulated that the German Navy would be greatly reduced and would have no submarines -- all U-boats and salvage vessels would be surrendered and those in shipyards broken up.

The success the Germans had with their U-boats had a further impact by motivating the Great Powers to explore limiting the numbers and capabilities of submarines. During the 1920s, the inter-war arms control efforts to control submarine warfare achieved some results.

- The Washington Naval Treaty of 1922 successfully limited the size of the major power's naval forces, but the British call for a total ban on submarines was rejected.
- The Three Parties Conference in 1927 resulted in the United States, Great Britain, and Japan agreeing to submarine force parity by limiting their numbers to 60,000 total tons, and restricting individual submarines to 1800 tons displacement, a 5" gun, and a 13 year lifetime.
- The 1930 London Naval conference further refined the submarine force level limit at 57,000 total tons. France and Italy, however, did not participate.

Further attempts to control submarine warfare in the 1930s highlight the pitfalls, and outright dangers, present when arms control negotiations are not conducted pragmatically. In 1933, Berlin began its clandestine submarine program and by mid-1934 had assembled the parts for its first 250 ton U-boat in Kiel.

The British recognized that Germany's rearmament would occur and attempted to avoid an all-out naval arms race.

Seeking to curb German naval growth, the 1934 Bilateral Naval Agreement was signed. This document restricted Germany to 35% of the Royal Navy's Surface Fleet -- and 45% of its submarine strength. However, it allowed Berlin in "special circumstances", to build its U-boat force to parity with the UK if another power built submarines above the treaty limit. Some attempts were made to control submarine force size, capability, and operations and levels somewhat above the 1927 and 1930 limits were established.

Included in the naval treaty setting limits at the 1935-36 conference was a special protocol banning unrestricted submarine warfare. This agreement was signed by 40 nations -- including Nazi Germany.

Britain's technology edge might have influenced London to believe they could afford to allow Germany to start a small submarine force to avoid an unwanted arms race during severe economic times. An out-of-the-political-mainstream Winston Churchill saw the issue clearly.

> "Great play was made by the British ministers with the Germans' offer to cooperate with us to abolish the submarine. Considering the condition that all other states should agree at the same time, and there was not the slightest chance of the other countries agreeing, this was a safe offer for the Germans to make. Negotiations with the Germans (could be considered) as the acme of gullibility and that what had been done was to authorize the Germans to build at their utmost capacity for five or six years."

Adolf Hitler's submarine warfare policy did much to neutralize the U-boat early in the Second World War. German Prize Rules were laid out in the manner agreed in the Anglo-German naval conversations of 1935 -- and in compliance with international law. Hitler's policy quickly lost credibility in the first days of the war when the U-30 sunk the liner ATHENIA -- with the loss of American life. Nevertheless, Hitler maintained his policy of non-provocative submarine warfare by giving direct orders that passenger ships would not be attacked, even if escorted.

Even without policy restraints, it is doubtful that the small German submarine force could have cut Britain's supply lines in 1939. Once again, Germany entered the war without sufficient numbers to make commerce raiding effective -- only 57 U-boats were in commission. In addition, U-boats were

involved in the support of German attacks on Northern and Western Europe.

Hitler shifted his naval strategy in 1940 when Germany was compelled to give up plans to invade England following the Battle of Britain. It did not seem likely that England would be defeated rapidly and submarine warfare appeared to be the most expedient way to cut England's sea lines of communication. In the fall of 1940, Hitler adopted the advice of Admiral Raeder and began a strikingly successful submarine campaign.

The U-boat strategy, however, was not without restrictions. Hitler continued to make a concerted effort to avoid drawing the United States into the war over the submarine issue. From the start of the war, German submarine commanders were instructed to avoid attacks on American ships at all costs. Indeed, the United States Congress cooperated in this effort by adopting the Cash and Carry Policy that prohibited American merchantmen from entering combat zones. As a result, submarine warfare did not emerge as the emotional issue to propel the United States into a European conflict.

Hitler, however, provided an excuse to further shift U.S. policy on March 25, 1941, by extending the German war zone to beyond Iceland. Roosevelt used Hitler's expansion of European war zones to justify extending American Neutrality patrols from 300 miles off the U.S. coast to just west of Iceland. This decision began an undeclared war with Germany. Initially, U.S. warships only cooperated with the Royal Navy by supplying contact reports on U-boats. This situation escalated in August 1941 when a U-boat, essentially acting in self-defense, fired a torpedo at the USS GREER -- actively assisting British ASW forces. The GREER Incident was quickly judged by Roosevelt as a deliberate attack and the President quickly authorized the U.S. Navy to use a *"Shoot on Sight"* policy against the *"rattlesnakes of the Atlantic."* This policy also allowed U.S. warships to escort convoys to Iceland -- giving the over-extended British ASW forces greatly needed support. These actions, however, were not without cost. U.S. naval forces soon discovered that the Germans could also shoot back as shown by the subsequent torpedoing of the USS KEARNEY and the sinking of the USS RUEBEN JAMES.

Berlin appeared to be holding fast to its policy of not provoking the United States to declare war -- regardless of U.S.

actions just short of war in the Atlantic. Restraints on the U-boat force prevented them from attacking convoys off the U.S. coast and U-boat commanders were still under orders to avoid incidents with American vessels. Hitler was engaged in the invasion of the Soviet Union and appeared to want to avoid going to war with America at the height of the Russian campaign.

The restriction placed on the German submarine campaign might have been in keeping with a well thought out foreign policy of restraint had Hitler kept the United States a hostile neutral. Four days after Pearl Harbor, however, Hitler declared war on the United States for no urgent -- or readily apparent -- reason. It is possible that Roosevelt's aggressive use of American ASW forces against the U-boats could have played a large role in Hitler's decision to declare war.

Hitler's declaration of war freed the U-boats from all policy restrictions. Tonnage sunk by the German submarine force dramatically rose in 1942 but German war aims would have been better served if these losses had occurred earlier in the conflict.

The United States submarine force was never saddled with the type of policy restrictions in the Pacific that the German U-boats faced in the Atlantic. With the exception of avoiding attacks on neutral Soviet merchantmen in the Pacific, unrestricted submarine warfare was the official policy against Japan.

U.S. submarine warfare policy was militarily and politically sound; particularly against the backdrop of Japan's surprise attack. It was an action that never would have been challenged by the American public. In addition, the U.S. unrestricted submarine warfare policy decision was handled in a very adroit manner. Strict secrecy was imposed on submarine operations to mask their operational effectiveness. The same secrecy, however, also served to avoid dealing with the issue of Germany being condemned for engaging in the same type warfare the United States was conducting with similar effectiveness and ruthlessness in the Far East.

The United States unrestricted submarine warfare campaign eventually proved to be a critical ingredient in Tokyo's defeat. Despite being initially hindered by faulty torpedoes and concentration on fleet operations early in the war, U.S. submarines eventually severed Japan's sea lines of communications.

The American submarine operations in the Pacific underscored the fact that technology made unrestricted submarine warfare a necessity for commerce raiding in hostile waters. Radar, sonar, aircraft, and convoys with their escorts, had advanced ASW techniques to the point where it would be virtual suicide for a submarine to operate in accordance with the existing rules of search and seizure. Nevertheless, Admirals Erich Raeder and Karl Doenitz, successively Commanders-in-Chief of the German Navy, were charged at the Nuremberg Tribunal with war crimes surrounding Germany's use of unrestricted submarine operations. These charges, however, were refuted by evidence at the trial -- including testimony by Admiral Nimitz, Commander-in-Chief of U.S. naval Forces in the Pacific -- that clearly proved the Nazis performed the same operations that the Allies did against the Japanese.

The Nuremberg Tribunal forced a change in the legal consequences of unrestricted submarine warfare in a total war. Its decisions, however, did little to legitimize unrestricted use of the submarine as a weapon of war in all circumstances. Conflicts fought since 1945 have presented opportunities to policymakers to make extensive use of the submarine, but with the exception of the Falkland Conflict, the submarine has played a limited operational role.

The Falkland Conflict illustrates that, in less than total war scenarios, the submarine may be viewed as a weapon of escalation subject to political restraint. Prior to the arrival of their task force in the area, the British placed submarines in the area to enforce their blockade of the island but these submarines did not attack any Argentine supply ships.

The British policy reflected the perception that submarine attacks are not automatically considered legitimate acts of war -- especially against merchantmen. In low-intensity politico-military situations, lethal submarine attacks on non-combatants would be out of place. To sink ships without warning -- the only way submarines can operate effectively -- would be fighting a war at a level out of step with the remainder of the international community.

The covert nature of submarine operations and its advanced command and control systems does allow the submarine to be a selective instrument of national policy. A sudden preemptive submarine attack can send a clear political and military message.

The HMS CONQUEROR's sinking of the Argentine cruiser GENERAL BELGRANO well outside Britain's announced 200 nautical mile exclusion zone clearly signaled the Argentine Junta of Prime Minister Margaret Thatcher's resolve to do whatever was necessary to retake the Falklands. The attack clearly stated that hostile naval forces would be at risk from sudden attacks from unseen attack submarines. This reality removed the Argentine Navy as a factor for the remainder of the campaign.

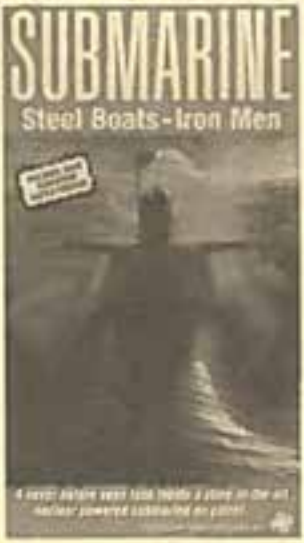
Submarine warfare has significantly demonstrated the potential to influence the outcome of both major conflicts and limited wars. From conflicts involving submarines and the efforts to control submarine warfare the following salient points emerge:

- The submarine offers a great military advantage to the country owning adequate numbers to pursue its policy and military objectives. The length of time required to construct a state-of-the-art submarine necessitates having sufficient number available at the start of a crisis.
- Political restraints can delay the effect of the full force of submarine warfare to the point where the effect is negligible.
- Sinking ships without warning remains an act of escalation to be employed selectively by the policymaker with care and restraint.
- The Nuremberg Trials provided realistic guidelines dealing with the legality of submarine warfare but in the international community, unrestricted wartime submarine operations have not yet been legitimized.
- Finally, submarine arms control and attempts to regulate submarine warfare have been difficult to accomplish.

■

SUBMARINE: Steel Boats, Iron Men

SPECIAL PRICE FOR NSL MEMBERS!!

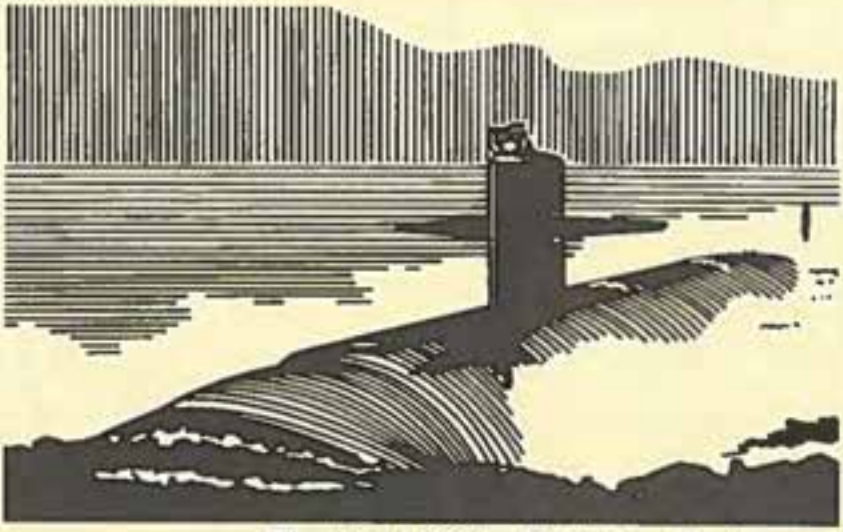


The NSL is pleased to offer its members VHS copies of **Submarine: Steel Boats, Iron Men** at a special price. The sixty minute film, produced by Varied Directions, Inc. with the assistance of the NSL, gives the public its first look inside a nuclear submarine in twenty years. A film team caught the Commanding Officer and crew of the USS HYMAN G. RICKOVER in action. Also included are interviews with some of the most honored submarine commanders, and an overview of the development and strategic use of the submarine in both world wars.

To order your copy at $49.95 plus $5 shipping and handling,
call 1-800-888-5236 or 207-236-8506
or write:
Varied Directions, 69 Elm Street, Dept. SR
Camden, ME 04843

(A portion of the proceeds will go to NSL)


WESTINGHOUSE AND THE SUBMARINE NAVY
THREE GENERATIONS OF QUALITY AND DEPENDABILITY MAKE WESTINGHOUSE THE CLEAR CHOICE FOR SEAWOLF
"Westinghouse makes them quieter, lighter, more powerful and cost effective." It's more than just a slogan. It's a fact, borne out by three generations of top-quality submarine propulsion systems—GE/HEP/PMP I and now, PMP II, the SSN-21 main propulsion unit ... the latest generation of quiet power designed for Seawolf.
To meet all the SSN 21 requirements, Westinghouse invested over $42 million to expand our manufacturing capabilities. We assembled a team of design, manufacturing and product support professionals second to none—a team whose abilities were proven on the successful GE/HEP and PMP I programs. And we've continued to refine and improve the design and ensure the quality of our submarine propulsion systems. The result is a lightweight, low noise main propulsion unit that gives new meaning to the phrase "quiet power."
From design through manufacturing, to field support, you can depend on Westinghouse ... clearly the low-risk choice for Seawolf.
WESTINGHOUSE MAKES THEM QUIETER, LIGHTER, MORE POWERFUL AND COST EFFECTIVE.



The Most Difficult Warfare Task Is The ASW Challenge.

Many of our undersea warfare systems perform multiple tasks and are critical to meeting today's evolving threat.

Sonars that seek out hostile submarines. Combat control systems for integrating sensors and weapons systems. Sophisticated, on-board training devices that develop, sharpen, and maintain the skills of shipboard personnel.

Submarine Signal Division is developing the CCS Mk 2 combat control system. It modernizes and standardizes equipment and software used in the U.S. Navy's submarine fleet. In addition to performance and operability improvements, the new system will reduce costs.

Raytheon Company. Where quality starts with fundamentals.

Raytheon

AN UPDATE ON AIR INDEPENDENT PROPULSION SYSTEMS

by Perry Wilkins

Although air independent propulsion (AIP) is not new, much has been written about it in recent years and some good development work has been accomplished. As is frequently the case during the development phase, much of what has been written has been associated with intentions and hopes instead of actual achievements. Additionally, through the course of development, things have been learned and goals have been adjusted accordingly.

The purpose of this article is to provide an accurate, consolidated update of achievements in AIP to date and to provide the reader factors to consider in assessing which is the best technology for different applications. Unless the requirements for a specific application are clearly specified, the danger exists of comparing apples to oranges.

Historically the USSR, UK and USA early recognized the military importance of AIP and conducted developmental work in this area. The U.S. conducted experimental efforts from 1955 to 1970 with the X-1, a 25-ton submersible powered by a hydrogen peroxide engine. The X-1 suffered at least one major explosion during its period of operation and the U.S. probably saw little reason to continue developmental efforts because of the impressive achievements with nuclear power.

The UK conducted somewhat more ambitious experiments between 1956 and the mid 60s with the EXCALIBUR and the EXPLORER. They were 750T (1000T submerged) submarines normally powered by diesel electric. They were fitted with CO_2/steam turbines for AIP operations using high test hydrogen peroxide and diesel fuel and were capable of 25kts. The success of nuclear power was undoubtedly an influence for UK to also discontinue efforts in this field.

The Soviets have been more dedicated in their development of AIP systems starting in the 1930s with closed cycle diesel (CCD) systems and continuing to the present time (1987-BELUGA). Although little information is available, their efforts have probably included units in the 1930s, 10 or more M-class units in the 1940s, QUEBECS (nicknamed ZIPPOS by their crews) with Kreislauf (LOX) CCD's powering the center

of 3 shafts, the 1500-ton WHALE in 1956 powered by a water hydrogen peroxide turbine, and possibly some ZULU, FOXTROTS, JULIETTS and KILO (1982) with CCD's.

Civilian interest in AIP appears to have begun in about 1965 with General Dynamics' installation of an Allis Chalmers hydrogen fuel cell (potassium hydroxide electrolyte) in the submersible STAR I. In 1969, Perry Co. installed a Pratt and Whitney hydrogen-oxygen fuel cell in the HABITAT HYDRO-LAB which operated in 50 feet of water off Palm Beach, FL. This unit could provide 5 kw at 28vdc for 48 hours but cost was a problem. In 1970, the submersible SP350 was operated off Marseille, France, with a hydrazine-hydrogen peroxide fuel cell. It made several dives of up to 15 minutes to depths of 265 feet. In 1980, Lockheed installed a Pratt and Whitney fuel cell in DEEP QUEST, which transited from San Clemente to San Diego submerged.

At present there are four candidate technologies for AIP systems. These are closed cycle diesel, sterling cycle engines, fuel cells and nuclear. Nuclear has been well developed in full scale military submarines (operated by 6 countries and accounting for 40% of the world's 950 submarines) but some work has been done recently for smaller scale civilian applications and hybrid (diesel and nuclear) military submarines, sometimes referred to as the SSn.

Each technology will be addressed, describing briefly how the system works, current status of development and points for consideration.

CLOSED CYCLE DIESEL (CCD)

A CCD system utilizes stored oxygen (either gas or liquid) and a working gas such as CO_2 or Argon. The exhaust gases are scrubbed or processed to remove combustion products from the working gas and then chilled, dried and filtered. Excess exhaust products are compressed and stored onboard or discharged overboard. Since combustion is never complete, even in an oxidant rich mixture, this recycling conserves both oxygen and fuel. The processed exhaust is combined with fuel and oxygen at the engine intake where vaporization and mixing (swirl) of components is very important. An oxygen rich mixture is established at the highest temperature practical for complete combustion.

There are currently two CCD programs of interest. One is a system called "SPECTRE" based on the earlier "ARGO" system which is being developed jointly by RDM (Dutch) and Cosworth Engineering (British). It uses LOX and Argon as the working gas. Argon was chosen to give the proper specific heat of combustion. The system has a patented exhaust scrubber, water management, overboard discharge system. It is reportedly efficient to 300 meters whereas previous CCD systems have been inefficient at depth.

The other CCD program is that of MARITALIA, an Italian group associated with the offshore oil industry. Over the past 10 years they have developed 12 to 250 HP series CCDs for submersible power and are currently developing a 150 ton submersible with a one week endurance. One of their most interesting units is the 3GST9 (3 inch pipe gas storage toroids, 9 meter long hull) which is presently being operated by the U.S. Navy to explore potential uses. The torodial pressure hull is unique and unusually strong. It allows considerable more usable volume for a fixed diameter vessel with a fixed volume for gas storage than any other storage arrangement, internal or external to the pressure hull. The 3GST9 weighs 24.3 tons dry, has a 620 meter operating depth (430 m DNV certification), an endurance of 34 hours at 6 knots, a 3 man crew and up to 6 passengers.

Technical difficulties and comparisons of the CCD:

- Short duration of the high temperature spike allows a much higher peak temperature without eroding the combustion chamber than in other designs such as the Sterling Engine.
- The CCD is more fuel efficient than the external combustion engine (Sterling).
- The CCD offers reliability at a reasonable cost (especially in civil applications where noise is not a serious consideration.)
- CCD equipment is compatible with existing infrastructure (especially fuel). It is theoretically possible to improve the efficiency of the CCD to rival other technologies, except nuclear, by turbo-compounding.
- The CCD direct drive is not subject to efficiency loss in energy conversion required by some other systems.

STERLING CYCLE ENGINE

The Sterling is a reciprocating external combustion engine with thermodynamically connected pistons that transmit mechanical work to a drive shaft and also move a working gas (helium) through a regenerator/cooler (heat sink) between hot and cold sides of the engine. Continuous burning in an external combustion chamber is kept in overpressure to facilitate overboard discharge of exhaust gases down to 300 meters.

Current Sterling Engine developments include the Swedish modified NAEKEN-class submarine (1000 ton) with 2 weeks or more submerged endurance and COMEX's (French) submersible SAGA which has Swedish built engines (2-150 hp each). Both vessels are presently operational.

Technical difficulties and comparisons of the Sterling Engine.

- The Sterling Engine is quiet due to external combustion, fewer moving parts, low system vibration and low RPM.
- Other external combustion engines include Brayton and Rankine cycle variants that rely on closed cycle turbines. They are smaller but less efficient than Sterling Engines and because of gear reduction they are noisier at low frequencies.
- External combustion engines can never reach efficiencies attainable in internal combustion engines since the high temperature end of the Carnot cycle is limited by combustion chamber materials.
- In the Sterling, energy is lost getting the heat from the external combustion chamber to the reaction mechanism.
- The Sterling is quieter at the high frequency end of the spectrum but roughly equivalent at low frequencies to the internal combustion engine.

FUEL CELLS

Fuel cells convert chemical reactions directly into electrical energy like ordinary storage batteries. Like in a battery, a positive and a negative electrode are activated by an ion conducting electrolyte. The fuel cell, however, produces electricity by a catalyst aided electrochemical reaction between a fuel and an oxidant. Power production continues as long as fuel and oxidant are supplied. The theoretical thermodynamic efficiency of a fuel cell is not Carnot cycle limited and therefore can be very high.

The first fuel cell was built by Sir William Grove in 1839. During the 1930s Francis T. Bacon made significant engineering advances and in 1959 he was able to produce a 5kw system to power a fork lift truck. NASA funded fuel cell development for space applications and DOE funded development for vehicle and stationary applications.

A variety of fuel cell types, in various stages of development, are available. In the literature, fuel cells are classified by type according to their electrolyte and catalyst systems. The fuel cell types in current use and development are:

- Alkaline Fuel Cell (AFC)
- Solid Oxide Fuel Cell (SOFC)
- Phosphoric Acid Fuel Cell (PAFC)
- Molten Carbonate Fuel Cell (MCFC)
- Proton Exchange Membrane Fuel Cell (PEMFC)
- Thin Film Fuel Cell (TFFC)

Each fuel cell type has different operating characteristics such as exhaust products, tolerance to impurities, response to cold starts, method of load following, required support systems, preferred fuel and oxidant, preferred power level and range, operating temperature and pressure and response to large and rapid load changes.

Current fuel cell projects include a TYPE 205 German submarine (450 ton) powered by a fuel cell which utilizes LOX and a hydrogen-metal hydride (heat activated). It utilizes a potassium hydroxide electrolyte and has a predicted 1 month submerged endurance.

Additionally Vickers Shipbuilding of Britain is working on a solid polymer fuel cell plastic membrane which holds the catalyst and it uses liquid methanol which produces hydrogen when passed through a reformer.

One of the most successful recent fuel cell projects is one completed by Perry Energy Systems. Theirs was a three year R&D program which married a proton exchange membrane fuel cell (PEMFC) manufactured by Ballard Power systems {1.5 kw (2kw max)} with a 2 man submersible, the PC 14. The system met all submersible application criteria and the range of the PC 14 was significantly increased (five hours at max speed). The PC 14's endurance was increased 3.4 times and the payload by 1102 pounds over that available from a lead acid battery pod. The system uses pressurized gaseous oxygen and hydrogen, so

no onboard processing is required. Resulting pure water is stored onboard so no weight change occurs during operation.

The Ballard Power System's fuel cell stack uses individual pressure regulators for a simple load following system. It is low cost and has high power density, and long service life. Gases are delivered to stack in excess of need for the reaction and excess gas carries water produced out of the stack where the water is removed and gases are vented. This is an open loop system.

Technical Difficulties and Comparisons of Fuel Cells:

- When operated below peak power, charge migration through the electrolyte causes a rapid drop in efficiency and a temperature increase requiring cooling pumps.
- To overcome efficiency drop below peak power, design for nominal power with batteries to take the peaks or alternatively banks of smaller cells to accommodate varying loads.
- Some question exists about the ability to start and stop cell banks smoothly and quickly on demand.
- Mature designs make use of expensive materials like gold, silver and platinum.
- H_2 stored as liquid requires refrigeration and has poor energy density.
- Metal hydride or similar compound has better energy density but greater bulk and weight.
- Newer aluminum/oxygen and iron/acid fuel cells are promising but not mature.
- Logistics of refueling is a problem.
- Gas hazards
- Electrical to mechanical conversion efficiency loss.
- Estimated 1 month submerged operations.
- Second highest efficiency (50-70%). Up to 5 times the net energy density of a lead acid battery.
- Very quiet.

NUCLEAR

When talking about a nuclear variant of AIP, we are talking about what has come to be called the SSn or the nuclear-hybrid submarine. Obviously nuclear submarines as built by the U.S., USSR, UK, France and China (India now has a Soviet CHARLIE) are air independent. The SSn, still only conceptual, is an attempt to design a submarine with capabilities and costs

somewhere between the diesel and the nuclear. It would be a modern diesel submarine with a relatively small reactor added to allow battery charging without snorkeling.

The French RUBIS - AMETHYST might actually already fulfill these requirements of costs and capabilities and in fact has been offered for export. The Canadians considered it before dropping their nuclear submarine acquisition program. Pakistan reportedly has shown some interest in the AMETHYST.

Although several other third world countries, including Brazil and Argentina, have shown interest in the SSn, the only known development work on the concept has been performed by a Canadian company, ECS Inc.

ECS designed a 100 kwe nuclear power plant called AMPS, for the French submersible SAGA. A test bed of this development has been completed and tested satisfactorily in a laboratory setting at Westinghouse, Hamilton, Ontario. This nuclear source, coupled to an organic Rankine Cycle Engine, is low temperature, unpressurized, intrinsically safe and would require minimal manning for operation. The nuclear core is the proven General Atomic TRIGA^R reactor core. ECS's major accomplishments in this project were the development of an innovative passive emergency cooling system and the development of a compact heat source of minimum weight. The passive cooling system has no moving parts and is capable of providing cooling in any altitude. Although production unit construction would present serious challenges, the compactness of the heat source is clever and accomplished, at least in part, by designing component parts (shielding, structure, reflectors, coolant, etc.) to serve multiple purposes.

Because of financial short falls, integration of the AMPS into the SAGA submersible has been delayed and probably will not occur at all.

As an extension to the above developed technology, ECS has investigated scaling the AMPS power output upward to that required for an SSn, about 700 kwe to 1700 kwe. In so doing some subtle changes occurred in the design. Higher primary temperatures, and therefore some pressurization, became necessary and the energy conversion unit was changed to a low temperature steam Rankine Cycle Engine. The passive cooling system and the intrinsically safe TRIGA^R fuel were retained in

the design. However it should be noted that the TRIGA^R fuel is manufactured in the U.S. and therefore not readily exportable for foreign military applications.

ECS has conceptualized the AMPS to provide a 2000 ton class submarine speeds up to 14 kts while supplying all ship's loads. Sprints at higher speeds could be made with the energy taken from the batteries restored later when the ship slowed. The AMPS could be enclosed in a 12m extension in a 7.5 m dia. hull with only slight effects on hull performance. The total weight increase with AMPS integrated into the hull is said to be about 500 Tonnes and refueling interval is 8 to 10 years. A net plant efficiency of 15.7% is calculated.

It is noted that no prototype or test bed for this sized design has been built and tested.

Technical Difficulties and Comparisons - Nuclear

- Most expensive - large support infrastructure.
- Licensing (nuclear) and liability insurance.
- Fuel - sources limited - nonproliferation agreements.
- Highest efficiency.
- Greatest refueling independence and range.

In summary, the world's interest in submarines continues to increase rapidly. Although batteries can sustain modern diesel-electric submarines with 4 to 10 days of air independent propulsion, high power density batteries have limited recharge cycles and thus significant cost considerations. Additionally longer periods of AIP are desired since snorkeling is a very noisy evolution with the snorkeler in a vulnerable condition with masts exposed and unfavorable acoustic factors.

Third world countries seek an affordable solution to the AIP submarine and as world economic factors shift, even the major powers may become interested in a high-low mix of AIP capable submarines.

■

SUBMARINE PERSONNEL EXCELLENCE
-- A RECRUITING PERSPECTIVE --

by Rear Admiral Henry C. McKinney, USN

Any visitor to one of our nuclear submarines is overwhelmed by the technology and complexity of the ship, is amazed by the compact and cramped spaces, and comes away from the visit with one constant and lasting impression -- the extremely high quality of the people serving in submarines. From seaman to captain, submariners come across as articulate professionals and outstanding examples of the quality of the youth in America.

The quality of our submariner today reflects the investment that we have placed in training and qualification. The Submarine Force training programs are the best and are the envy of the rest of the Navy. There is no need to go into the history of the development of our outstanding training, but clearly Admiral Rickover had a significant influence. From the beginning of the Nuclear Power Program, Admiral Rickover placed a great deal of emphasis on individualized training that was carefully structured and based upon mastering the fundamentals of science and mathematics. His penchant for excellence has had a dramatic impact on the quality of all training that we conduct in the Submarine Force today, from formalized classroom instruction to shipboard seminars. Involvement of all hands in training, from the Commanding Officer on down, has become standard and is the accepted norm throughout the submarine force.

Our quality enlisted and officer personnel in submarines are the product of the exceptional training programs that have been in effect since the 1950's, but there is another side to this story. The quality of the input into this magnificent training pipeline must also be considered. Clearly, Admiral Rickover concentrated a great deal of his own personal time on this aspect of the problem in his personal interview and selection of officers for nuclear power training. His standards for acceptance of officers were extremely high, and for good reason too, as the nuclear training program was, and still is, an extremely difficult academic challenge. As we entered the 60's and shifted to the direct input officer, greater emphasis was placed on the academic credentials of the individual in college or the Naval Academy.

Engineers and those with majors in hard science were preferred. By the early 70's, it was clear that USNA and NROTC could not meet the demands of the growing nuclear power program and Recruiting Command was tasked to provide an ever increasing number of officer candidates. By the late 70's, recruiting had met the challenge with the Nuclear Power Officer Candidate (NUPOC) program and during the 80's over 40 percent of the officers entering the nuclear power training pipeline were NUPOCs.

Extremely high selection standards were established for the NUPOC program, and once firmly established on the college campuses, this program has been extremely successful. Although the typical NUPOC enters the Navy with considerably less knowledge of Navy tradition and lore than his NROTC or USNA counterparts, this disadvantage is rapidly overcome during the training pipeline, and by the time they reach the fleet, any notions of *90 day wonders* have been long forgotten. The quality input of officers to Nuclear Power School has gotten better each year, the academic demands of the training pipeline are more stringent and as a result, the quality of the nuclear trained submarine officer continues to remain high.

What of the enlisted submariner? Have there been parallels in the recruiting and training of enlisted nucs? What about the other ratings in submarines? Are there any special recruiting efforts for enlisted submariners? Just as with the officer, an enormous effort has gone into the recruiting of quality individuals for our enlisted submarine force. The story begins with the beginning of the all-volunteer force in the early 70's. Navy recruiting, during the draft era, depended largely upon *volunteers* who were trying to avoid being drafted into the Army, and so they enlisted in the Navy. The Submarine Force received more than its fair share of the quality from these *volunteers*, particularly the nuclear power program, as many had several years in college or had college degrees, and they saw the nuclear power program as a way of building on this background. This phenomenon was also very evident in all the technical programs in submarines; e.g. sonarmen, fire control technicians, and electronics technicians.

When the draft ended, there was considerable apprehension as to whether the Navy could sustain a strong technological base in the enlisted community. Without a draft forcing more

educated men into the Navy, it was not clear that we could man our ever increasing technically sophisticated Navy. Several manpower studies were undertaken. Many of these studies were negative toward our expanding nuclear submarine force. One study in particular questioned our ability to man the rest of the Navy technical ratings given the draw on quality demanded by the Nuclear Power Program. This study was designed to make the case for fewer nuclear ships and submarines since we would be unable to man them. Needless to say, history has borne out the fallacy of this particular study. Although the quality manpower pool is not limitless, there are sufficient quality personnel who possess strong technical skills and are interested in joining the Navy.

For the past 20 years, special emphasis has been placed on recruiting for the Nuclear Field Program. In order to promote the Nuclear Field Program, we utilize high quality nuclear trained enlisted submariners who have volunteered for a tour in recruiting. Typically these are First Class Petty Officers or junior Chief Petty Officers with 7 to 10 years of service. Bright and articulate with a great deal of enthusiasm and pride in their Navy, they are assigned as Nuclear Field Coordinators in one of the 41 recruiting districts around the nation. The majority of their time is taken up making presentations to high school chemistry and physics classes. These presentations cover some of the basics of nuclear propulsion plants, dispel the myths concerning nuclear power, and stress the quality and capabilities of our nuclear submarine force. Navy recruiting also administers a Nuclear Field Qualifications Test to potential nuclear field applicants. This test is not an aptitude test, rather it is a test to measure the specific level of knowledge of the candidate in math, physics, and chemistry. This test is the only test authorized by the Department of Defense for individual service use, and is a recognition of the Navy's specialized requirements for nuclear field recruiting. All other recruit testing is standardized for use by all services.

Only 10 percent of the 18 year old males meet the basic standards for the Navy's Nuclear Power Program. That is, they are high school graduates medically and morally qualified for the military and achieve a test score in the upper 50 percent of the nation. Of this group, only 20 percent will be able to achieve a qualifying score on the Nuclear Field Qualification

Test. Detailed police record checks and the requirement for a drug free background, except for limited experimental use of marijuana, further reduces the qualified market. Only the highest quality individuals are allowed to enlist in the Nuclear Field Program. Those that don't make the cut on the Nuclear Field Qualification Test, but who meet all the other mental, physical, and moral standards are screened for other submarine programs.

Recruiting generates a great deal of interest concerning the Nuclear Power Program and the Submarine Force among high school juniors and seniors. As a result, the top quality of the individuals that are recruited as high school seniors are placed either in the Nuclear Field Program or in one of the other six year obligator submarine training pipelines. Continued success of these submarine recruiting efforts will depend upon continued positive publicity and image of the submarine force. **"Hunt for Red October"** had a significant impact on submarine recruiting, but equally important was the Submarine League documentary film **"Submarine: Steel Boats, Iron Men."** This film is on video tape and is available in every recruiting station in the country, and it will have a long term positive impact on our submarine recruiting efforts -- more so than "Hunt for Red October."

The quality of our submarine force is refined and polished through well-established and successful training programs, yet, its very existence is guaranteed by our efforts to seek out and accept only the best qualified individuals. Given this high quality of officers and men in the Submarine Force, it goes without saying that we will continue to enjoy the outstanding image that our submarine and nuclear field recruiters portray in high schools, and I am confident that we will continue to enjoy serving with the highest quality enlisted community in the Navy. ■

THE LOSS OF THE SOVIETS' MIKE

W. J. Ruhe

On 7 April, 1989, the KOMSOMOLETS (the "MIKE") while at a depth of 50 meters and southwest of Bear Island (at the top of the Norwegian Sea), caught fire at 1102 and six hours later sank in 4,500 feet of water. The sequence of events leading to the loss of this 1000-meter depth Soviet submarine and the damage control actions taken to save the KOMSOMOLETS should be of great interest to all people interested in submarine matters. Fortunately, *glasnost* in the USSR has permitted a great deal of unclassified information on the MIKE's sinking to be disseminated by the Soviet news media. It has also allowed relevant authoritative statements to be made by Soviet naval personnel, including the most senior officers in the Soviet Navy.

Significantly, the KOMSOMOLETS sank in a matter of hours because of fire effects, whereas other Soviet subs consumed by fire took a day or more to sink. Pravda, a Soviet newspaper, on May 24, 1989, emphasized that "Never had a fire-stricken submarine sunk within a few hours!" Admiral Cherkashin's implication that "a sub with its reservoirs of oxygen next to tanks of oil (high pressure air bottles were evidently above the oil stowage tanks in Compartment #7) and the air-vitalization plant next to bottles of hydrochloric acid" were booby traps waiting to be sprung, proved disastrously true.

Aware of a fire in electrical equipment in Compartment #7, the Captain of the MIKE ordered the ballast tanks blown with the high pressure air systems in order to surface the submarine. Thus, the high pressure air line running through #7 -- with its plastic seals melted and an electric arc having ruptured the line -- was incorrectly used to blow the after group of ballast tanks. This released a great amount of high pressure air into Compartment #7. (Solid-fuel gas generators were in all ballast tanks and might better have been used to blow the MIKE to the surface from deep submergence, in this emergency.) The high pressure air leaking into #7 fed a fire fueled by oil stowed there. It jammed the door from #7 to #6, and it quickly created so much heat (1,000°C) and pressure (13 kg/cm^2) that the stuffing gland seal around the main shaft leading from #6 through #7 to the single screw, was destroyed. (This seal could

not withstand more than 1.4 kg/cm^2 of pressure.) At the same time, the cables through the hull in #7 caught fire and their stuffing boxes were burned out, causing leakage from the sea into the compartment. The first booby trap was sprung.

Then, at 1624, after more than five hours of fire fighting and with the Captain still certain that his submarine was in stable condition and could be saved (the MIKE's Captain Vanin, at that time, said, "*There was no thought of sinking.*"), the second booby trap was activated. Seven "air vitalization canisters" in Compartment #6 "blew up" with great force. (The "airtight vitalization tanks had oxygen-generating plates made of a material capable of burning even in water", according to Admiral N. Cherkashin.) The explosion of the canisters apparently ruptured the titanium pressure hull which was probably weakened by the great differential in temperature between the cold sea-water-exposed outer and the very hot inner side of the hull. This allowed heavy flooding into "the after three compartments" and resulted in the KOMSOMOLETS sinking stern first within 40 minutes.

The spread of fire through the MIKE tells the story of the difficulties encountered by damage control personnel. Their successes in combating various effects from fire shows that there was a good deal of efficiency shown below decks.

With a major fire started in Compartment #7, which contained the electric controllers and operating gear for the rudder and planes, an alarm and indicator at the damage control station in Compartment #3 warned that #7 was exceeding 70°C of temperature. There was, however, no pressure gauge on the panel to subsequently warn of the build-up of pressure in #7 caused by the ruptured HP-air line.

Within a minute of the start of the fire, "a watch stander in #6" began feeding LOKh, a "fire extinguishing chemical" (freon) into #7. But it failed to produce the desired result of snuffing out the fire because the high pressure and high temperature generated in the compartment seriously reduced the efficiency of this fire-fighting system.

An attempt was then made to get the man on watch at the electric controls in #7 out of the compartment, but with the door between compartments jammed, he evidently perished from inhaling the freon or from the effects of the fire.

The jammed door plus the ruptured seal around the main shaft allowed smoke and flames to shoot into #6. Quickly, the "right turbo-generator in #6 was observed spurting turbine oil which atomized in the high temperature developed and caught on fire causing a raging uncontrollable fire in #6 as well. Air pressure also built-up in #6 to about 13 kg/cm^2 and this high pressure, now in the after two compartments, was not measurably reduced for the next 44 minutes.

Early in the emergency, a short circuit in the power network caused a large number of small fires throughout the submarine. "Certain instruments failed to withstand the tremendous surge of current before the safety system could operate." Most noticeably, a fire broke out in the damage control panel in the control room. But it was readily eliminated using a fire extinguisher.

Aware of the fire in the MIKE's stern compartment, Lt. I. Orlov, in Compartment #4, rapidly and efficiently secured the reactor. He "lowered the compensating grid onto the lower end pieces shutting the reactor down 100%. After the emergency control rods in the reactor had gone down automatically, he brought the fuel rods down as far as possible. He then checked instruments to confirm that the reactor had cooled to 35°C in the first loop." The autonomous reactor systems would operate even if the sub's entire power network failed. Also, the reactor's protection system is automatic. (A Norwegian scientific team, within a month after the MIKE's sinking determined that there was no sign of excess radiation or loss of nuclear material from the reactor on the ocean floor. The reactor, according to TASS of April 12, 1989, was designed to withstand the 150 atmospheres of pressure to which it is now exposed. Also, the nuclear weapons carried, though on the bottom, are designed to remain intact at the depth of the sunken MIKE.

Shortly after the fire in #7 was evaluated by the MIKE's skipper, he brought the submarine to periscope depth and then to the surface at 1116, with the propeller stopped and with jammed stern planes and rudder. The MIKE was slightly down by the stern. (Months after the disaster, Soviet Admirals had the MIKE at over 150 meters depth when the fire started. Was this to infer that Soviet submarines can be brought competently up from a greater depth than that from which open sources

reported the U.S. Navy's THRESHER was at when it failed to rise to the surface?)

LOKh was fed into #6 from #5 at about 1115 with no resulting damping of the fire in #6. At this time, it was noted that all communications aft of the control room were lost, and the diesel generator for carrying the electric load was promptly started by Captain 3rd Rank I. Spenkov. But at 1145 the diesel cooling system failed and the diesel engine stopped.

Fires broke out in Compartment #4 and in the engine control compartment #5 at 1121, with five men in #4 seriously burned before the fires were brought under control in a matter of a few minutes.

The fire fighting situation was badly aggravated by a leak in the MIKE's special fixed-breathing system, according to Admiral Chernavin. The people who plugged into the line while working in compartments filled with smoke were poisoned. At 1212 three people in Compartment #2, (the living quarters), who were using the sub's emergency breathing apparatus passed out due to the carbon monoxide fed into the line from a leak in the line in #7. The men were promptly taken topside for revival.

The individual breathing masks donned by fire fighters were not altogether fit for the job, Admiral Chernavin noted. "After 20 minutes in an asphyxiating environment the users became unconscious in their masks. When brought topside and then forced to abandon the submarine they were so weak in the 3°C water that they drowned."

At 1645, just prior to the order to "Abandon Ship", Compartment #1 was unsealed and its battery hold rigged for ventilation, probably to reduce the possibility of battery explosions during evacuation of the MIKE.

Just before the MIKE sank, Captain Vanin climbed into the escape chamber (VSK) and joined five other members of the crew inside. After securing the lower hatch to the VSK, an attempt was made at 1705 to free the capsule as the MIKE started sinking rapidly. However the VSK was secured too tightly to the MIKE's hull to be broken free. (The VSK had previously torn loose during a storm and had surfaced spontaneously. So when it was recovered it was overzealously re-secured to the MIKE's hull.) As the VSK, still attached to the submarine, passed about 400 meters of depth it lost its air-tightness so

the smoke and gases from inside the MIKE leaked into the VSK affecting the occupants and causing them to don rescue masks. At approximately 600 meters depth, heavy internal explosions were heard and felt within the VSK and were thought to be the bulkheads collapsing -- indicating that the bulkheads had a failure pressure of about 50% of the MIKE's pressure hull. These explosions evidently broke the VSK loose and it started its ascent to the surface. On hitting the surface, the upper hatch blew open due to pressure inside the capsule and two of its occupants were catapulted into the 3°C sea -- with only one surviving. The carbon monoxide gas which had leaked into the VSK caused the others to perish.

Prior to the escape capsule's tragedy, it had taken 1 1/2 hours to jack the 25-man life raft containers topside into a position to be used. The gears had a small travel and had evidently "become rusty during the MIKE's 39-day voyage."

Significantly, the MIKE had been operated for a prolonged period of time at 1,000 meters depth during its deployment -- probably to test the utility of their sonars in the deep sound channel and the MIKE's torpedo offense and defense capabilities at such a depth.

In addition to the scenario detailed above, there were public statements by Soviet sources about damage control deficiencies which were revealed well after the MIKE's sinking. A listing of these deficiencies sheds some light on why things happened the way they did:

- the KOMSOMOLETS was on her maiden voyage "with its second crew", a practice seldom observed. Thus, according to Admiral Cherkashin, "the second crew had trained on a simulator far from all systems mockups of the 'prototype';"
- Soviet secrecy had in the past concealed its naval accidents, preventing a dissemination of lessons learned from previous submarine fires;
- Captains of Soviet subs were not allowed to send out an SOS, hence in this emergency the response from other rescue activities lagged;
- the MIKE's small crew of 68 might have provided too few damage control people to adequately handle the emergency experienced;

- the MIKE was an "experimental submarine" solving 12 important problems during the patrol;
- Soviet submarine damage control instructions do not deal with a 2-compartment fire;
- it was indicated that a Soviet submarine should be expected to survive the total flooding of a single compartment, and in some cases the flooding of non-adjacent compartments, but that "two adjacent compartments cannot be flooded and still survive;
- not all routes for the spread of fire had been considered in the design of the MIKE;
- below decks, there was no comprehensive system for evaluating the situation in the damaged compartments;
- the personnel did not assume their Damage Control Bill stations in a timely manner;
- there were no heat resistant suits or asbestos masks available;
- safety gear was stowed in positions which were difficult to reach;
- evacuation of personnel, particularly those injured or unconscious, from the MIKE was less than satisfactory;
- and there were no Kingston valves in the main ballast tanks, reducing reserve buoyancy as water in the tanks fluctuated with the MIKE's pitching.

The story told here is not a pretty one with its loss of an advanced type of attack submarine and the perishing of 42 people on board. Much information about Soviet submarines was revealed by this incident and should be carefully and well digested -- because the concept of *glasnost* may well be repealed in the near future, with information about submarines again relegated to tight security.

■


In the defense
of our nation, there can be
no second best.
716
Newport News
Shipbuilding

THE SUBMARINE IS THE MOST COST-EFFECTIVE WARSHIP IN *ANY* NAVY.

A U.S. submarine with cruise missiles has — on a much smaller scale — military characteristics which are a lot like those of a carrier battle group:

- **can mount an air attack on targets hundreds of miles inland**
- **rapid deployment without basing issues**
- **virtually unstoppable by any nation**

While the air strike power of the SSN is far less than that of a carrier battle group, the cost is even further less. So, if you don't have enough carriers, send an SSN or two.

With SEAWOLF's much greater weapons payload, SEAWOLF's ability to handle larger, longer-range cruise missiles, and with more countries becoming able to attack our carriers with nuclear weapons, the SSN air strike option will become even more important in the late 1990's.

A PLAN FOR NEW RESCUE VEHICLES

by Jack A. Vaughn

After the THRESHER loss in 1963, the Navy embarked on a program to provide a viable method of rescuing personnel from a submarine that was disabled on the ocean's floor with one or more compartments relatively intact. The primary method selected was the Deep Submergence Rescue Vehicle (DSRV) with the associated equipment needed to operate from specially configured attack submarines of the SSN 637 class and from the two PIGEON class ASRs. Two DSRVs were contracted for and built. After delivery, a long and arduous testing phase was carried out to verify that the DSRVs met the requirements set forth by the Navy. Since 1977, the two DSRVs have been maintained in an ashore facility (Deep Submergence Unit) at the Naval Air Station, North Island. Over the period of time, these DSRVs have operated in several areas, including Scotland and Norway, using various support submarines and both ASRs. These vehicles are operated by Navy crews and are assisted in their maintenance by Navy personnel at the DSU and by contractor personnel.

The vehicles were originally designed for a ten year life with specific criteria on the number of dives to maximum depth per year. It was determined that the pressure hull was not being subjected to the number of cycles anticipated and the service life could be extended. A modernization program was begun that was designed to extend the service life to the year 2010. One of the DSRVs has had a new control system installed and the second DSRV will have a similar system installed together with other mechanical improvements during an overhaul that began in mid-1990.

Although the modernization is ongoing (at a slower pace than was anticipated due to funding availability), the year 2010 will soon begin to play a significant factor in the planning for future operations. The need to establish criteria for follow-on vehicles is rapidly approaching in order that an orderly planning and acquisition cycle can be carried forward.

After the requirements for replacement units are specified, it may be difficult to persuade Congress to spend the money on

such a project. Instead of acquiring replacement DSRVs in the normal manner, it might be the time to approach the problem from a different aspect. A possible way to fund the replacement is to allow industry to provide the equipment and personnel as a service. To a degree, it would be much the same as having a tug under long term hire, answerable to a specific Navy command. The selected contractor would design the vehicles, construct them, man them, carry out training and actual rescues as designated by the Navy, maintain the vehicles and update them as required or as specified by the Navy. This method would call for the amortization of the cost of the vehicle, its maintenance and personnel over the period of the hire. The contractor would provide in his proposal a yearly price to cover the costs of building and testing of the new vehicle, the training costs of the various personnel and the costs of repairing, modifying and supporting the vehicle. This yearly cost might be more heavily weighted in the early years of the program to allow the contractor to recover his acquisition costs and would allow for escalation of the costs based on a mutually agreeable formula. In this mode, the Navy would specify the characteristics that the system must have and the period that the hire would be funded. Industry bidders would then be free to ascertain how best to build a replacement DSRV, how to acquire and train personnel for operating and maintaining the units, and how to maintain and upgrade the units over the period of the hire.

The heart of this concept would be the design and construction of the new units. Certain constraints in the form of requirements would define how the task could be undertaken. For example, to avoid causing significant cost to the support submarines, it would be necessary to specify that the physical interface between the DSRV and the support submarine in the form of the attachment points would remain as at present. But other items such as specific sonars, design of the hydraulic systems, and type of the life support systems would be at the discretion of the builder. Since the builder stands to gain by keeping the price low, it would encourage him to not overdesign but to meet the requirements at the minimum cost. The vehicles would still have to conform to the Navy's certification for manned non-combatant submersibles. It should provide a

means of allowing alternate approaches to the same problem with the added incentive of saving money.

The contractor would be responsible for providing personnel for operating and maintaining these units. The expected advantage of this method is in the lowering of the turnover rate now experienced when using Navy crews. The current method of manning with Navy personnel is always fighting the short time that personnel are assigned and the lack of continuity that arises by the continual training mode. Although the present crews of the DSRVs are drawn from submarine qualified personnel, due to the uniqueness of the two vehicles, a qualification program for new personnel is required. It is expected that many of the personnel would be drawn from people that have separated from the Navy and the Submarine Force and who desire to utilize their talents in this field. However, well trained technicians that have not served in the Submarine Force can well be used in the maintenance functions. This manning method should decrease the overall number of personnel needed as they would not be required to carry out military duties and the rotation of personnel would not be a factor. The contractor would have the responsibility for the coordination of repairs between the maintenance personnel and his subcontractors to insure the minimum down-time of components.

The contractor would have to conduct maintenance actions similar to the current Restricted Availabilities and Overhauls. The periodicity of these actions might be different than now, but it would probably be a function of equipment that was installed. Within the constraints of certification requirements, the contractor would be free to determine how best to maintain the efficiency of the vehicles and what repair methods are the most usable. Since the contractor is in full control of the repair of components and usage rates, he would be attuned to determining components that have a higher than normal failure rate, or that require excessively large amounts of effort to repair, and could act to replace or improve the discrepant components.

Over the period of the contract, improvements to the vehicles could come about in at least two ways. The first would be to improve the operation of the vehicle by changing systems, components or other units on a replacement type arrangement. An example of this improvement might be the change of the

type of valves used in a particular system. This improvement would be funded by the contractor as it would contribute to his improved operation of the vehicle. The second would be as the result of the decision of the Navy to install a new capability in the vehicle over and above that originally required. The requirement for a new sonar which was not specified at acquisition might be an example. The cost of this type of change would be a matter of negotiation between the Navy and the contractor, similar to the existing system for modifying the DSRVs.

As in any new way of accomplishing a task, there are problems that must be addressed and overcome. One of the foremost in this plan is the need for a different method of contracting than is normally used. The Navy would be asking a contractor to build, maintain, man and upgrade vehicles for a long period of time, probably 25-30 years. Much of the early cost will involve designing and building vehicles to carry out the task. Additionally, projecting costs over a 25 year period is a very risky task. Therefore, the contracting procedure should have the capability of allowing mutual modification of terms as the years pass and that can be used over the life of the vehicles.

The Navy presently has certain fixed facilities such as the buildings presently housing the DSRVs which could and should be used in the new scheme. Because the facility needs to be adjacent to a large military airfield to allow transporting the rescue vehicles world-wide to conduct the rescues, it would appear that the present location is excellent and the facility should continue to be used to support the new vehicles. Also some maintenance and support equipment could be used. The usage of these items would lessen the costs, and therefore, should be made available to the selected contractor.

The contractor's crew would have to be embarked on the ASRs or support submarines during actual or practice rescue missions. They would have to have access to areas which are under security clearance requirements and therefore, must be able to be properly cleared and allowed access. Given the proper attention, this aspect should not be a large problem. There may be need to revisit the existing (and future) Memorandum of Understanding with foreign governments and amend them as necessary.

NATO is currently conducting a study to determine whether NATO should acquire a Submarine Rescue System for the many submarines of the NATO nations. This study is to determine what type of rescue system should be acquired, how many systems should be acquired, where they should be based, and how the system should be owned, i.e., should it be owned by one or more countries, owned by NATO, owned by civilian contractors. NATO is looking at a ready date of 1998 for their system, if acquired. This study is on-going and the results are to be completed early in 1992.

The program specified above could provide the Navy with new Rescue Vehicles in a time of decreasing budgets by utilizing a different mode of acquisition. Further, it would reduce the personnel demands on the Submarine Force by passing the operation and maintenance of these vehicles to a contractor. This idea is presented as one possible means of providing new assets but there are many more ways that it could be accomplished. It is hoped that this article will cause some interest in the process and that this (and other) methods will be explored. One point is very clear, however, and that is that specific requirements for the new vehicles must be the product of the Navy's need. The specific requirements should be carefully drawn to encompass the lessons learned from the many years of operating the present DSRVs and they should be limited to those necessary to carry out the rescue mission without incurring high costs to achieve minimal results. Unless the Submarine Force is prepared to remove the possibility of personnel rescue, the program for new Rescue Vehicles should be approached in a timely manner.

■

SUBMERGED UNREP FOR SSNs

by R. Thompson

It is well known that current U.S. SSNs carry only on the order of twenty or so tube-launched weapons, with the improved 688s carrying up to an additional dozen weapons outside the pressure hull. Today, such a limited magazine capacity, comprising a mixture of Harpoons, Tomahawks, Mark 48s and perhaps other weapons, overtly limits the SSN's effectiveness.

There are several reasons why a twenty-plus weapon loadout represents a severe handicap. Most important, the missions and effectiveness of the submarine have expanded vastly, and we can anticipate a commensurate increase in weapon expenditure. For instance, the main mission of submarines in World War II was commerce destruction. At that time, a thirty-plus weapon load was evidently adequate, since few U.S. subs returned to base having expended all their weapons (when they worked).

In comparison to the U.S. fleet sub of fifty years ago, today's SSN is not only faster and of unlimited endurance, it also has better sensors and fire control, and has access to satellite reconnaissance. Unlike the submarines of fifty years ago, today's SSNs can find, trail, and attack a convoy at will, and maintain contact for an arbitrary length of time. An SSN attacking a surface action group or convoy might anticipate a running fight lasting days, with the attacking sub firing dozens of weapons. Among these, missiles are likely to be fired in salvos rather than singly, to saturate and confuse the defenses of the surface vessels. Other missions might also demand a heavy expenditure of weapons. Tomahawks are likely to be heavily used when possible in any land conflict where the opponent has a significant anti-air capability and might contest control of his littoral waters; under conditions where a plane and pilot would be seriously at risk, Tomahawks will be employed. Can anyone doubt we would have used hundreds of SLCMs against heavily defended North Vietnamese targets if they had been available?

The Iranians recently reminded the world of the effectiveness of a few (obsolete) mines in the right place, and the value of submarines as a covert dispenser of mines is well known. It would be surprising if any potential naval opponent believed our

SSNs could not lay mines. The character of the SSN as a multi-mission platform is beginning to be appreciated, but its ability to do many things on a single voyage is jeopardized by a limited magazine capacity. Finally, the addition of twelve vertical launch tubes to the Improved 688s and the inclusion of space for a reported 50 weapons in the SEAWOLF design suggests the importance our own Navy attaches to this issue.

Unfortunately, the majority of our submarines will carry only a score of weapons until well into the next century, with little prospect of increase. For surface vessels, their magazine capacity is less of an issue, since with UNREP and VERTREP, they can rapidly transfer ammunition and other supplies, even while underway. For submarines, the story is different: shipping weapons is a ticklish business even in a calm harbor, and foolhardy under any other circumstances. The Soviets occasionally load weapons at sea, but their subs have notably greater freeboard than ours. Thus to reload, or to change weapons for a different mission, our submarines must return to a protected harbor or anchorage, perhaps with a submarine tender. In a future general war, this probably means returning to U.S. bases, since forward, improvised bases will almost certainly come under attack. Moreover, a submarine tender is difficult to hide from a satellite, and one with a few subs nestled alongside makes a soft, inviting target for precision-guided munitions. Yet if weapon expenditure rates are high, SSNs might spend a large portion of their time transiting to and from an operational area. For instance, an SSN (theoretically) tasked with a mission in the Sea of Okhotsk might spend two weeks getting there from Pearl Harbor, a few weeks performing that mission, and two weeks getting back, all the while under threat of attack. Although the mission is accomplished, the SSN is actually carrying the fight to the enemy only a fraction of its time underway. The German U-boats sunk in the Bay of Biscay in WW II en route to their operating areas in the North Atlantic are examples of submarines being interdicted well before they threaten their targets.

Thus our objective is to develop a safe, stealthy method for replenishing SSNs while at sea.

Ideally, the SSN would like to ship weapons while submerged, since it is stealthiest, least vulnerable, and best able to defend itself while submerged. The German WW II method of using "milch cows" for refueling and resupplying while on the surface

is clearly unsatisfactory, since the U-boats were helpless when attacked during these evolutions. Underwater supply transfer might be possible if the supply ship were itself an SSN and the weapons were transferred by divers while both submarines were stopped and submerged. The supply submarine and the SSN rendezvous using their precision navigation systems at different depths to avoid collision: for instance, the SSN might be at 100 feet keel depth and the supply ship at 225 feet. The weapons are almost neutrally buoyant (or could be moved in containers that assured this), and at these depths wave effects are negligible. The weapons are transferred by divers from the supply ship to the SSN through the latter's torpedo tubes. The SSN's torpedo tubes would have to be slightly modified for this purpose. The supply ship would probably be a modified Poseidon SSBN with its missile tubes replaced by weapons shipping gear and a decompression chamber. The decompression chamber is required to maximize diver efficiency at the depths required. The evolution would be easiest carried out with the SSN drifting passively, and the supply vessel obliged to maintain station; the supply vessel would require small thrusters, a precision depth keeping system, and a (probably optical) system for discerning the attitude and relative position of the SSN. Naturally, the trim and depth of both vessels will change slightly as weapons are loaded, or as a result of variations in current or salinity, and it will be the responsibility of the supply vessel to maintain a safe horizontal and vertical offset. The evolution is envisioned with the supply vessel at greater depth than the SSN, to minimize the depth change which the divers must undergo; probably about 80 feet. However, it might be simpler and safer to maintain a satisfactory vertical offset with the SSN underneath the supply ship, since the SSN will tend to sink as it loads and the supply vessel will tend to rise as it unloads. Clearly the utility of this technique will depend on the speed and safety with which it can be done, which in turn is largely controlled by the ability to safely maintain a small depth offset.

The advantages of this approach are many. First, the entire evolution would be carried out underwater, with the submarines listening passively, and able to defend themselves. The resupply could conceivably be done anywhere, in any weather; underneath the polar ice cap might be a particularly good place. The

resupply would be fast, since the weapons need not be shipped one at a time; a converted SSBN could carry however many divers were necessary. We note that while 100 feet is uncomfortably shallow, it is comparable to SSBN launch depths, and there is no signature at the surface; naturally, the rendezvous will be chosen to be away from sea lanes or probable ASW forces. Obviously, other supplies, including food, spare parts, and other expendables could be transferred. The SSN would not have to cut short a deployment or make a long, slow, transit back to a protected base.

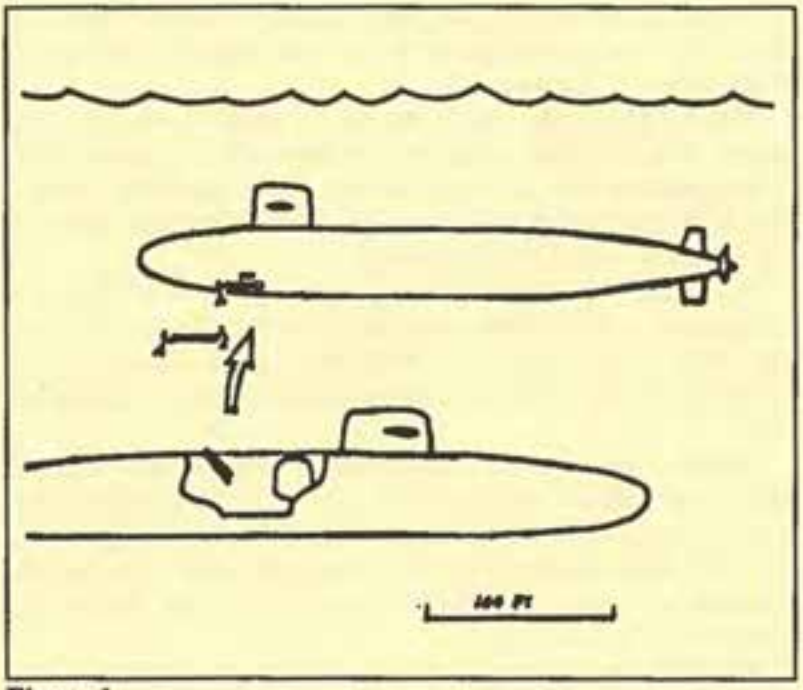


Figure 1.

Weapons transfer from a modified SSBN-640 class supply submarine to an SSN-637 class attack submarine, approximately to scale. The weapons are extracted by the divers from the hatch(es) at the rear of the SSBN's missile compartment (cutaway), transferred to the SSN and shipped through the torpedo tubes. Note the decompression chamber also installed in the SSBN's missile compartment.

■

EVOLUTION, REVOLUTION, AND REFINEMENT
or
THE GOLDEN AGE OF SUBMARINES

by M. H. Rindskopf

This is not another U.S. Navy submarine history.

For the sake of this discussion, let us divide the 20th Century into three essentially equal parts: 1900 to 1940, 1940-1970; and 1970-2000. These segments match the title. More important is the middle third for it was during these years that the author was privileged to be involved with the Submarine Force in several capacities.

The cat is already out of the bag, I would presume. The period of **Revolution** is the Golden Age of Submarines, AND it encompassed the author's career. What could be neater? The task now is to prove the proposition to the satisfaction of the denizens of the other windows.

There are a multitude of books which trace the history of submarines in the world as well as in the U.S. Navy. We need not reinvent the wheel, but rather will cite a few sources, and comment briefly upon the key steps leading to the true submarine.

The **Evolution** delivered to the **Revolution** the Fleet Boat, so tabbed because it was assigned by the strategists of the inter-war years the task of scouting for the Fleet. It is generally agreed that that fortuitous decision (wrong though it was) gave us just the ship to wage a successful trans-Pacific war against the Japanese.

But, the Fleet Boat didn't just happen. It was the product of forty years (and much more) of tedious effort by civilian inventors, U.S. and foreign, contributions by foreign navies, and concerted U.S. Navy design and construction.

From history ...

- The submersible

  1780 - The challenge of defeating the blockade off ports in the U.S. and elsewhere was met as early as the U.S. Revolutionary War by Bushnell and Fulton with

production of one-man manually propelled craft which could approach an anchored target undetected in order to attach an explosive charge to its underbody. (TURTLE and NAUTILUS)

1880 - In rapid succession in U.K. and Sweden, Nordenfelt and others introduced steam propulsion on the surface with residual steam for brief submerged periods; then electric propulsion submerged using batteries in their infancy; and Holland's internal combustion engine with electric propulsion; but not until 1904 did the French introduce the diesel engine for safer propulsion power. (NORDENFELT I, RESURGAM, NARVAL, FENIAN RAM)

1890 - Double-hulled ships, and in 1910, internal tankage for trimming, quicker diving (negative), and torpedo compensation (WRT) were introduced.

- Control Systems

1888 - One periscope and in 1914 two scopes (DELFINO)

1890 - Stern and later bow planes for diving and submerged operations; and casings for effective surface cruising.

1910 - Gyros

- Torpedoes

1868 - Whitehead type, the first for tube firing, 14" x 11', 6 knots, 200 yards run with 40 lbs of explosives;

1890 - 18" x 16.5', 30 knots, 1,000 yards run with 200 lbs of explosives;

1914 - 21" x 20', 29 knots, 10,000 yards run with 225 lbs of explosives.

The U.S. Navy formally entered the submarine business on 11 April, 1900, when it made John Holland immortal by the famous photograph of him with the derby in the hatch of SS1.

Thereafter, a succession of submarine classes, from A through S, gradually, but certainly not without travail, increased capability in size, diving depth, speed, and numbers of torpedo tubes. It was only when the U.S. Navy entered seriously into the design function that the Fleet Boat concept evolved.

From 1925 onward, V, P, S, T, and MACKEREL classes joined the Fleet. They brought a standardized length and displacement, internal arrangement, higher speeds and better submerged endurance, 10 torpedo tubes, and the earliest

electro-mechanical fire control which fired the 1914 Whitehead torpedo.

In summary, **Evolution** bequeathed the Fleet Boat to **Revolution.**

Admittedly, World War II was the catalyst for many of the spectacular improvements the Submarine Force adopted. Funding was essentially unlimited, R&D flourished, patrol operations encouraged initiative, and enemy (German) developments were copied. Submarines matured in a hurry.

The War saw the introduction of radar, both for air early warning and for surface search, passive electronic countermeasures, electric wakeless (Mk18) and passive acoustic torpedoes (Mk27-4 and 28), and improvements in both passive and active sonar.

Wartime operations elicited a steady stream of ideas for improvements in all aspects of the submarine and its outfit. These appeared in profusion.

Even in the post-war retrenchment, submarine improvements blossomed (with the help of captured German U-boats): the snorkel (or should we say schnorkel?), the Guppy conversion (from the Type XXI), the bow mounted sonar (from the Prinz Eugen).

These, in turn, spawned further innovation, some again from the Germans. The greatest leap forward, perhaps, was the ALBACORE tear-drop hull which multiplied submerged speed and maneuverability. The use of high-yield strength steels for hulls expanded the depth envelope markedly. But other developments were important too. Amongst these, in the 1950's, were the wire guided active/passive torpedo (Mk37), electronic miniaturized fire control (Mk101 and subsequent), surface launched cruise missiles (LOON and REGULUS), SSKs designed to fight a submerged battle with enemy submarines, periscope mounted radar, AND NUCLEAR POWER!

There is no need to expound yet again upon the impact of nuclear power on submarines and submarining. It took us to the true submersible. That spawned further technological improvements such as inertial navigation, highly sophisticated environmental control systems, and weapons which integrated the command systems with fire control and sonar, and even nuclear warheads for torpedoes.

Nuclear power developed faster than hull forms, so it was not until SKIPJACK, the third class of SSNs, that the ALBACORE hull was wedded to nuclear power. By 1970, there were 45 SSNs, mostly 594 and 637 classes.

Concurrently, studies were initiated to take ballistic missiles to sea. The first candidate was the liquid-fueled JUPITER which would be fired from an awash condition. The twin dangers of liquid fuel and exposure for firing soon pushed JUPITER aside in favor of a more submarine compatible system. This led to the establishment of Red Raborn's Special Project Office with success following success. Attack submarines under construction were stretched to SSBNs, and the schedules were telescoped. The first submerged POLARIS firing by GEORGE WASHINGTON took place on 19 July 1960. By 1967, 41 POLARIS submarines were operational.

Before moving to the final era of the 20th Century, there is one non-submarine system which must be mentioned because of its impact upon submarine development (quieting), missions (ASW), and tactics (long range detection, air/submarine coordination, integration of command and control systems, and development of torpedo firing doctrine). This, of course, was the development of land-based area detection systems in both the Atlantic and Pacific theaters. It impacted heavily on U.S. submarine development, but it also drove Soviet improvements because it effectiveness was obvious: first to Soviet diesel boats and later to their SSNs and SSBNs.

While COMSUBLANT, Vice Admiral Bacon commented at the dedication of Ramage Hall SubTraFac in Norfolk in June 1989. Those words serve as a fitting conclusion to the "Golden Age". He said (in part): "Despite a massive technological evolution, many of the fundamental principles of submarine warfare, forged in the *fire of combat* (my emphasis) have clearly stood the test of time..."

A solid technological base and highly professional personnel were the legacies of the Golden Age of Submarines.

Just because I have categorized the 1970-2000 as the Age of **Refinement** does not mean that there were no major steps forward. I do not denigrate the efforts of the submarine team afloat and ashore in any manner. They have married modern computer techniques, massive R&D, and innovation in myriad directions to enhance the quality and capability of today's

submarines. We see progress in all phases, with one exception, perhaps.

The cost of new submarines has far exceeded inflation to the extent that force levels are established more by the budget than by strategic requirements.

Having given **Refinement** its proper obeisance, let's assess the elements which comprise the whole.

The submarine

The 688 class is the primary attack submarine of this period. It, like its 594 and 637 predecessors, emphasizes quiet operations and sophisticated sonar detection capabilities. It is considerably larger and faster but this is not revolutionary change. Every U.S. Navy ship class, submarine or surface, has ultimately been modified to the point where there was no further space or weight margin, and a new class came into being. The 688 is no exception. The last few 688s are *improved*; improved to the extent that space and weight permitted. Then follows the SSN-21, the submarine of the next century, as the name implies. It will have limited impact upon the Force in the late 1990's only because its numbers will be few. It will reflect developments and refinement over 19 years since the introduction of the 688.

But, it is driven by nuclear power, the product of the Golden Age; it will have more torpedo tubes than the 637 or 688 but fewer than its WW II forebears. Its sonar and command and control are more sophisticated than the prior classes, but are conceptually similar.

The weapons mix of this last period is impressive although the Mk48/ADCAP is based on a design of the late 1960s. And some will claim that even HARPOON and TOMAHAWK have ancestors with names like LOON and REGULUS, not to mention the Soviet SS-N-X family of cruise missiles.

TRIDENT, the only submarine even close to the world's largest, the Soviet TYPHOON, is arguable the world's quietest when it so wishes. It is POSEIDON reincarnated -- more tubes, better sonar, better stealth, better patrol endurance, better turnaround -- yet a concept developed in the Golden Age.

A final word on personnel is in order. Only in this past period has the submarine become the principal ship of the Navy, even the capital ship. Thus, it is no surprise that submarine flag officers have risen to four-star rank by reason of their

careful selection, their demonstrated intelligence and performance, and their association with the key force in the Navy today.

Epilogue

We, graying or gray, balding or bald, who were privileged to fight the War against the Japanese and drive the Submarine Force with such success through the Golden Age salute today's highly talented team. We know they will continue to build upon our legacy (it's already been over 20 years). They will succeed in reshaping the Force technologically and operationally to meet the electrifying political and military changes unfolding as Communism collapses.

■

THE BEDPAN STORY

by Vice Admiral James A. Zimble (MC) USN

As requested by the Editor of this REVIEW, I shall try to put to paper my infamous bedpan story which I would entitle, Confessions of a Submarine-Qualified Surgeon General. You can call it anything you want. It's certainly hard to believe that one insignificant bedpan can, if properly deployed, totally mission degrade a 100 million dollar (1960 dollars) state-of-the-art, HY-80 steel encased, nuclear-powered fleet ballistic missile submarine. Truly incredible.

First, a little background. I reported to the precommissioning Blue Crew of USS JOHN MARSHALL (SSBN 611) at Newport News Shipbuilding and Drydock Company in October 1960, as an eager young Medical Corps lieutenant who had just completed one-year's training at Deep Sea Diving School, Naval Gun Factory, Washington, D.C; Basic Submarine School, Nuclear Power School, and Undersea Medicine School, New London, Connecticut; and Nuclear Propulsion Prototype Training, West Milton, NY. Needless to say, I was raring to go even after learning that I, a full lieutenant, was the most junior officer on board. The skipper was a four-striper, the XO a three-striper, and almost all department heads were LCDR's. Such a top-heavy wardroom was the standard for FBM's in those days, albeit quite humbling for a post internship physician.

The CO and I developed a tenuous relationship of mutual respect. How could the relationship be otherwise between a young Jewish doctor and a senior officer who was a Christian Scientist? I truly admired him for his knowledge, skill and demeanor as a superbly competent "NUKE" and leader ... and for his willingness to comply with the dictates of allopathic medicine -- once I had given him a full dissertation on the pathophysiology, therapy and prognosis of any disease process which might affect a member of the crew. Incidently, our relationship improved immeasurably when he realized that I could completely alleviate his symptoms of chronic mal de mer when he rode the bridge by administering just one Bonamine tablet (which must assuredly have been a disappointment to Mary Baker Eddy).

His nickname was "Steely Blue", an appropriate name for a stern leader whose azure Paul-Newmanish eyes never blinked nor strayed from anyone receiving one of his earnest lectures; and he was extremely proud of the fact that he and he alone had achieved the noteworthy reputation of always leaving the yard exactly on time for sea trials and had always returned on time ... or early ... after fully completing all trials without untoward event. It was a reputation of which anyone would be immensely proud. Little did he know how precarious such a reputation might be with an allopath on board.

I apologize for the length of this *background material*; however, I don't know any other way to give proper impact to this complex tale. You need to know that I was blessed with two very experienced Chief Hospital Corpsmen who through great patience and forbearance were able to break me in to the arcane practice of medicine aboard a nuclear-powered submarine. The sick bay was directly beneath the Control Room in Ethan Allen class boats, which meant that the access hatch of the radar mast well was in sick bay spaces. One of my corpsmen was rather compulsive about neat, orderly and safe stowage of all equipment. In fact, he was positively obsessed on the subject. Now, all masts on our submarine had an under-ice position to protect them when surfacing beneath ice. By tripping the under-ice switch in the Control Room two chocks holding the mast were hydraulically activated, allowing the mast to settle to the bottom of the mast well. Since Newport News is located in relatively southern waters, it should come as no

surprise that the masts were never tested in the under-ice position after initial installation.

Back to my compulsive Chief. Soon after beginning to stow medical gear in our sick bay, he came upon the access hatch to the radar mast well. Imagine his ecstasy as he discovered the almost made-to-order fit: our one and only bedpan in the void between the bottom of the mast (when supported by the chocks) and the floor of the mast well. It was indeed a bedpan locker. And for the next several months that was where our bedpan was stored ... until that fateful morning.

On 25 November 1960, the Friday after Thanksgiving, having completed all sea trials, we were scheduled to commence our shakedown cruise. We were to sail early in the morning up the York River to Yorktown for our load-out of torpedoes with which we were then to test our capabilities in Newport. The evening prior to departure a recently reported officer was OOD. He was extremely earnest, and he intended to make an extremely good first impression. Therefore, whilst on watch, instead of relaxing so that he could properly digest his Thanksgiving dinner, he proceeded to test all masts -- including the radar mast, of course -- in the under ice position. All masts tested perfectly. No problems were encountered ... until the following morning, the morning of scheduled departure, when it was discovered that we had no radar. We had no radar because the wave guide was totally mangled by a remarkably resilient bedpan resting in the mast well.

I have never before or since witnessed as angry an individual as Steely Blue was that morning. And I have never before or since suffered the experience of having someone that angry with me. Sure, the ship was delayed (mission degraded) for almost four hours -- four truly unbearable hours for the members of the USS JOHN MARSHALL medical department. Yes, the Friday after Thanksgiving was a holiday that year, so the workmen had to be paid triple time for their repair work. But worst of all, the skipper's reputation was irrevocably destroyed. His anger was justified and appropriately directed. It is quite remarkable and of great credit to his ultimate philanthropy ... and my utter amazement ... that subsequent to this incident I have been able to be promoted beyond the rank of Lieutenant, Medical Corps, United States Navy. ■

LETTERS

THE THRESHER MEMORIAL

As a matter of interest, I have received some mail on the THRESHER article in the January 1991 REVIEW (all favorable). One letter was from Roy Anderberg, a NSL member and World War II submariner. He inquired about his old WW II Submarine, USS TORO, which had been slated to be sunk in the waters near the supposed location of the THRESHER. Of course, the TRIESTE found the THRESHER before the TORO sinking was necessary. The TORO was later sold and scrapped. Art Gilmore remembers that the TORO was painted with white stripes for purposes of determining dimensions in some sort of a visibility experiment in the Atlantic waters. I was able to send Roy copies of the pages about TORO from the Dictionary of American Naval Fighting Ships published by the U.S. Naval Historical Center of the Department of the Navy and Art Gilmore's recollections.

Dan Curran

UPDATE

At the end of Dan Curran's article "Remembering the USS THRESHER," in the January issue of the REVIEW, we listed an address for donations to the SCORPION Memorial Fund. We have since learned that address has changed to:

Mr. Larry Rollins, Chairman
U.S. Submarine Veterans National Memorial Funds
Box 2932
Freedom, NH 03836

SOME MORE THOUGHTS ON UNMANNED SUBMARINES (UUV)

A major concern in reading Captain Lanning's article "Some Thoughts on Unmanned Submarines (UUV)" in the July 1990 issue of the SUBMARINE REVIEW is the submarine's lack of ability to launch and recover efficiently and tactically the menagerie of UUVs destined to evolve once the first autonomous UUV has proven its worth at sea. The scenarios described by the author are closer to reality than many submariners realize as the persistent quest for UUV technology is pursued. The need for an effective launch and recovery system grows in importance.

As the author suggested, perhaps unknowingly, when he stated "submariners had best study the history of AIR WAR!", a solution appears relatively near at hand. A concept named Submarine Lateral Launch System (SLLS) sponsored by DARPA recently finished hydrodynamic tests at David Taylor Research Center (DTRC) using a 1/7 scale SEAWOLF model in DTRC's deepwater towing basin. Essentially, SLLS uses the same technology as the aviation community to eject weapons laterally from wing mounted weapon carriages. Phase I development testing of SLLS was completed and UUV launch and recovery was demonstrated successfully throughout a full range of tactical speeds. Hopefully, the Navy will pick-up the development of SLLS when Darpa lets go.

In summary, I continue to be amazed at Dick Lanning's ability to get to the heart of the matter. Either by intuition or luck he describes the UUV situation correctly.

Captain O. V. Shearer, Jr., USN(Ret.)

■

IN THE NEWS

• Over the first months of 1991, hard news about submarines in the American Press was relatively sparse, and what there was of it appeared to be compressed into about a half-dozen topics: a reduction in the number of SEAWOLFs to be built, the consequent threat to the submarine building yards, the TOMAHAWK firings in the Gulf, the announced closing of our base in Holy Loch, and the issue with the TRIDENT missile. Of course, that was all some fairly big news but with massive coverage of the air and ground war, not much of it seemed to get to the general public.

• DEFENSE NEWS of January 14th reported that "The U.S. Navy plans to buy only five SSN-21 SEAWOLF attack submarines, not the 30 originally planned, before ending the program in 1994." The industry paper cited unidentified *sources* for that figure, but went on to state that "In its budget submission, the Navy is proposing building one SSN-21 and two SSN-688 LOS ANGELES-class submarines as the first phase in moving toward an alternative submarine."

• Concerning the submarine industrial base problem, NAVY NEWS & Undersea Technology, on February 18th, published an Industry Analysis piece which stated: "The Navy's latest submarine building plan is leading to concerns that the price of the SSN-21 may never dip below $2 billion while the industrial base of shipyards and suppliers may be devastated. Although the Navy may have had little choice due to the Pentagon's budget wars, the result may be thousands of lost jobs, bankruptcy of any number of vendors and a significant threat to one of the two submarine-qualified shipyards." DEFENSE NEWS of the same date reported that "Industry officials say cutting the rate for the Navy's SSN-21 SEAWOLF nuclear attack submarine program from 1.5 vessels per year to one in the 1992 budget raises the possibility that only one shipyard may compete to build the submarine in the future."

The local southeast Connecticut press understandably gave prime coverage to an appearance there by Senator Daniel K. Inouye (D-HI) on January 22nd. As the Chairman of the Defense Appropriations Subcommittee, Senator Inouye was quoted as saying "You can count on me doing everything possible to assist EB." and "...I will not preside over the demise

of the Defense Department." The NORWICH BULLETIN went on to credit the Senator with holding out "...two possibilities that could offer a brighter future for EB and its subcontractors." The article reported those possibilities as (a) the use of submarines as underwater platforms for TOMAHAWK missiles, and (b) a higher level of defense spending if the Gramm-Rudman cap could be removed.

- On the subject of TOMAHAWKs, the DEFENSE NEWS of February 4th offered the opinion that "The impact of U.S. submarines firing cruise missiles in support of Operation Desert Storm will likely be more political than military. Their use could play a large role in shaping congressional and defense industry, officials say."
- Concerning Holy Loch, the NEW YORK TIMES on February 6th, reported that the British Defense Secretary, Tom King, told the House of Commons that the United States nuclear submarine base at Holy Loch, Scotland, will close sometime next year. The article went on to quote Mr. King as saying that the U.S. would no longer need the base because it was replacing the obsolete POSEIDON missile submarines with bigger TRIDENT boats.
- Questions about the TRIDENT missile were reported by INSIDE THE NAVY on January 21st. The article covered the findings of the Drell Committee, a panel of experts convened by Congress to look into nuclear weapons safety. The paper quoted the group's report with "The TRIDENT (D-5) missile system presents a special case to consider in the recommendation policy review." and "...the design choices that were made for the W-88 in 1983 raise safety questions:

  ▸ 1. the warheads are not equipped with insensitive high explosives and are mounted in a through-deck configuration in close proximity to the third-stage rocket motor that uses a high energy 1.1 class detonable propellant. Today, seven years after these design choices were made, we have a new and better appreciation of uncertainties in assessing, for example, the probability that accidents in handling the D-5 missile system might lead to dispersal of harmful radioactivity;

  ▸ 2. the country has different perceptions of its strategic needs in the post-Cold-War era;

▸ 3. the public has very different perceptions about safety; and the acquisition of W-88 warheads is still in the early stages and has been interrupted for the present and near-term future by the shutdown of the Rocky Flats plant where new pits for the nuclear primaries are manufactured."

On March 1st, The Washington Post quoted Charles M. Herzfeld, Director Defense Research and Engineering, as having told the House Armed Services Committee that the Navy has altered procedures for loading nuclear warheads aboard TRIDENT strategic submarines to reduce further the risk of an accidental explosion. The article explained that the change had been made as a "quick fix" to warhead and missile safety problems identified by the group chaired by Stanford University physicist Sidney Drell.

• A submarine-related item was reported in the Washington Times of February 28th. In discussing problems with the pending Strategic Arms Reduction Talks Treaty and the bogus data being received from the Soviets regarding conventional forces in Europe, it was stated that the Soviets told us in November that they were building *zero* new submarines. CIA Director William Webster was quoted, however, as telling the Senate that "...additional submarines are under construction, and they may carry a new type of ballistic missiles."

• In one other bit of submarine coverage, DEFENSE NEWS reported on February 25th that "German government officials are working to conclude a $1 billion military and humanitarian aid package to Israel that includes nearly $600 million for the construction of two diesel electric Dolphin class submarines, German and Israeli officials say."

■

U-BOATS IN THE BAY OF BISCAY

An essay in Operations Analysis, by Brian McCue.
National Defense University Press, Washington, DC,
September 1990
Sold by the U.S. Government Printing Office.

Reviewed by W. J. Ruhe

For the submarine buff who has a smattering of operations analysis, this book is a gem. Moreover, anyone with today's knowledge of *systems analysis* -- with its derived graphs, models, statistics, mathematical equations, etc. -- can readily relate to this book, though it deals with yesterday's analysis of the U-boats in the Bay of Biscay in World War II.

What the author, Brian McCue, presents exceptionally well are the analytical findings about submarine warfare as related to a specific campaign -- one in which Allied ASW aircraft tried to prevent the German U-boats from transiting the Bay of Biscay to get to the North Atlantic convoy lanes. From McCue's findings, broad principles of submarine strategies are made evident, many of which seem applicable to today's submarine warfare. In fact, there is an obvious similarity between the GIUK barrier and the "fence" across the Bay of Biscay for preventing submarines from getting out into the Atlantic.

In the words of Vice Admiral J. S. Baldwin, "This study is not for the casual reader looking for the romanticized battles of the North Atlantic." It does however "challenge the reader intellectually and offers in return, many fresh insights into modern man's attempts to evaluate quantitatively -- warfare," and particularly submarine warfare.

Some of the insights derived in this book are truly profound and are described here to entice potential readers to read and digest the *conclusions* reached by McCue. The detailed analytical data, graphs, derived tables and methods shown, are worth sifting through to see how operations analysts arrived at important observations about submarine warfare.

Early on, McCue defines the difference between the operations analysis he used in this book and *systems analysis* (so

popular in today's military world). Operations analysis, he notes, "uses present and historical data to produce quantitative conclusions about ongoing or past operations." Systems analysis on the other hand, "provides an understanding of future or hypothetical systems" -- and in such usage, "works with fewer facts and thus has a harder job than his or her operational counterpart."

The scenario of this Bay of Biscay campaign from 1942 to 1944 shows first the effects of introducing new technologies and soon their being countered by other technologies. The conduct of the ensuing battle of technologies is then related to the submarine war in the North Atlantic and how changes in strategies, tactics and policies impact on the overall results.

At the start of the Bay of Biscay antisubmarine battle, British aircraft employed the ASV Mk II radar, which could detect surfaced subs up to 10 miles. When within a mile of the submarine, the radar lost the sub in sea clutter. Hence, the ASW bombers used a carbon-arc searchlight to localize the surfaced German subs at night, for the final phase of the attack. The British were moderately successful in attriting U-boats sailing from the French ports during early 1942.

Then, a British bomber crashed in Tunisia in the spring of 1942 and the Germans recovered a Mk II radar from it. To counter this radar, the Germans adapted a French device, the Metox intercept receiver, for their U-boats. This successfully detected the British Mk II radar emissions and hence the Germans were "wildly enthusiastic" about this solution. They even began running surfaced in the daytime across the bay and became extremely effective with their wolfpacks because of their great mobility while running on the surface.

But by early 1943 the Germans had lost confidence in their Metox device. Their U-boats were frequently being surprised by Allied aircraft at night. The Metox receiver, a heterodyne unit, was broadcasting a signal which could be intercepted by Allied aircraft at "fabulously long ranges." Hence in May 1943 the U-boats went to sea with a new Naxos receiver which was totally covert and successful in intercepting MkII radar signals.

However, at about the same time the Allies introduced the Mk III radar, a magnetron-generating 10 centimeter S-band signal which Metox could only marginally detect. Admiral

Doenitz in fact thought the British had shifted to using an infra red device.

In November of 1943 a Wellington bomber crashed in France. It was carrying a Mk III radar and showed the technology which had to be countered. Yet, not until April 1944 did the Germans introduce a new S-band search receiver into their U-boats. Before this, however, the British had deployed an X-band radar and by mid 1944 the Germans had developed the Tunis receiver as a counter.

At the same time the Germans introduced the snorkels into their submarines, tending to minimize the effects of introducing new radars, -- and their countering -- to the transit problem across the Bay of Biscay. The snorkel had such a small radar return -- at most one third of a surfaced submarine -- that ASW aircraft were no longer very effective. At the same time the Germans were introducing the Walther hydrogen-peroxide propelled U-boat along with the GNAT homing torpedo as countermeasures to the Bay of Biscay offensive.

While the electronic war was ensuing, Admiral Doenitz used other measures to get his submarines safely to sea and to maximize their patrol usefulness. The Allies similarly had counters to Admiral Doenitz's actions.

By late 1942 Doenitz started using resupply submarines in the mid-Atlantic to reduce the number of transits of U-boats through the Bay. By prolonging a U-boat patrol time, through a refueling and reprovisioning operation, the U-boats went from an average of about 2 ships sunk per patrol to about 12 ships sunk per extended patrol. Each submarine tanker could service at least 10 submarines. This strategy paid off handsomely until about July 1945 when the toll per submarine dropped to about 5 ships per patrol.

The British deciphering of the Germans' Enigma code resulted in the gleaning of information of tanker rendezvous with subs, allowing attack by Allied aircraft of submarines being refueled, resulting in considerable loss of U-boats. U-boat communications with their bases was their undoing.

By April of 1943 the Germans were so unsuccessful in getting their boats safely across the Bay that Doenitz shifted to their running submerged during the night and running on the surface during the day -- ready to shoot down attacking ASW aircraft. Single boats did so poorly against the ASW aircraft however,

that Doenitz configured special FLAK boats -- boats heavily armed with anti-aircraft weapons -- to patrol the Bay and shoot down ASW aircraft. But, the Allies escorted their ASW aircraft and destroyed the FLAK boats. This led to about five boats transiting during the daytime together -- all armed with anti-aircraft weapons and mutually supporting each other against attacking aircraft. But this worked only poorly and was abandoned.

During 1943 Admiral Doenitz became painfully aware that there was a great backlog of submarines awaiting refit. The repair facilities in Western France were so poorly manned and spare parts so sparse that submarines spent exorbitantly long periods of time awaiting their refits after a patrol. Thus putting more money and effort into refits was indicated, so that more submarines could cross the bay per month -- thus reducing the attritions per transit.

The U-boats also began using a decoy named Aphrodite to cause searching ASW aircraft to investigate a false contact. Operations analysis however quickly determined that search aircraft were investigating, at all times, so many false contacts during a single air patrol, that adding a few more had little effect.

Doenitz also routed his boats along the Spanish coast in Spanish territorial waters, to reduce the attrition of his U-boats. But that only marginally affective.

Operations analysis also showed that for British ASW aircraft the "miles flown in the operational area" were the fundamental measure of effective ASW search rather, than "the hours flown."

It became obvious that "only in the Bay of Biscay and near the Allied convoys could Allied aircraft find submarines often enough to make search efforts worthwhile." And the "offensive campaign in the Bay proved fruitful enough to warrant the continued diversion of aircraft and crews from the 'defensive' task of protecting convoys."

Operations analysis also showed that "the operational use of intelligence in the Second World War made a contribution which is hard to assess and was of mainly indirect value." Doenitz's assessment however was; "decryption results were worth an additional 50 U-boats." That was a doubling of strength to him.

As a result mainly of the Bay of Biscay operations, the words which Winston Churchill wrote: "the only thing that ever really frightened me during the war was the U-boat peril" were put to bed by Admiral King's report in April 1944 which downgraded the U-boat "from a menace to a problem."

Admiral King summarized this Battle of Biscay as an interplay of new technical measures and opposing countermeasures. "In the see-saw of techniques the side which countered quickly, before the opponent had time to perfect the new tactics and weapons, had a decided advantage."

How this Bay of Biscay battle might play-out if applied to the possible battle in the GIUK gap between nuclear submarines, is interesting to contemplate.

■

TAKTIKA PODVODNYKH LODOK (SUBMARINE TACTICS)

by Vladimir A. Khvoshch

reviewed by LT Robert E. Clark II, USN

The ability of one to defeat an adversary is proportional to one's true understanding of how an adversary thinks and intends to employ his forces. Taktika Podvodnykh Lodok (translated: Submarine Tactics), by Vladimir Khvoshch is the first known book length publication written on Soviet submarines, and their tactics, by a Soviet author. This book gives the perspective of a Soviet in the area of submarine warfare and therefore makes it invaluable reading to anyone seriously trying to understand Soviet submarine tactics or how the Soviets think in terms of submarine employment. Taktika Podvodnykh Lodok is a publication with two purposes. In essential content, the book was written as a text for naval officers so as to expand their professional knowledge level with respect to submarine warfare. The writing style and words used by the author express various themes that are more conducive to the academic and political sectors of Soviet society versus the military audience that the publication appears to be focused towards. Besides being an excellent source book in terms of understanding Soviet submarine employment, Taktika Podvodnykh Lodok allows the thoughtful reader insight into the present day military budget debate being fought in the Soviet Union. The book is an

attempt to prove the submarine force's worth, from a budgetary standpoint, and it's importance to future national defense.

As a reference source, in terms of submarine employment as expressed by a Soviet, the book offers insights into various areas of Soviet submarine operations as well as insight into how the Soviets view the *Western* threat. There are numerous tables that list not only U.S., but other *Western* Antisubmarine Warfare (ASW) assets and their extrapolated capabilities. The tables seem to be included as a reference more than anything else, for at no time in the book does V. Khvoshch infer that various technical improvements within the Soviet submarine force had come about because of *Western* advances. In fact the author makes it a point to show that most advances in ASW emanated from Soviet designs and ideas.

The technical and organizational layout of the book is very methodical and matter of fact. The author systematically presents the various types of submarines in the Soviet inventory and explains in basic terms their capabilities and employment potential. The presentation of the various submarine platforms as "multi-mission capable", reflects the Soviets' general trend in constructing naval vessels as well as assigning some to extremely unconventional roles. V. Khvoshch mentions amphibious transport submarines, and submarines used in an air defense role. Both amphibious transport and air defense seem almost unrealistic missions for submarines when viewed with *Western* prejudices, but when put in a Soviet context they are quite logical. For example, air defense (as viewed by a Soviet) means the elimination of forces capable of launching an air assault on the Soviet homeland or Soviet forces -- such as an aircraft carrier. Understanding the words and examples presented in the book, in the context of Soviet thinking, allows the reader to see beyond the mere words.

Along with the Soviet trend of multi-mission combat platforms, their methodical and statistical approach to warfare is extremely evident throughout the book. Almost all submarine employment situations, and operational considerations, are simplified into relatively basic statistical models which are then analyzed and explained to illustrate the Soviet submarines combat effectiveness, especially in the realm of ASW. Though the book in basic concept is a text (from a Soviet perspective)

on submarine warfare, the actual themes presented and the words used reflect a deeper purpose.

The Soviet military is presently undergoing an exhausting justification process from both the political and academic sector. In a time of *glasnost* there is much debate on the issue of "reasonable sufficiency" with respect to national defense. In an era of *perestroika* there is a drastic need to cut costs in all sectors of the military so as to try and salvage the Soviets' crumbling economy. Taktika Podvodnykh Lodok is an attempt to justify the Soviet submarine program, and its future, with respect to national security in a time of economic despair.

V. Khvoshch utilizes historical cases to make the point that submarines have consistently been the force of choice in crippling offensive minded super powers (the author uses Hitler's Germany by example but infers the present day U.S.) The author also notes the technological advances with respect to missiles, in particular the use of cruise missiles by submarines. Because of the advent of submarine launched cruise missiles, V. Khvoshch argues that a cruise missile carrying submarine, in a strike role, can be considered a strategic asset. The theme of a non-ballistic missile carrying submarine having a strategic role is a significant change from previous Soviet literature. At first one would conclude that the strategic role associated with a submarine would be directly related to whether or not the submarine was carrying cruise missiles. The fact that the author talks of submarines in a strategic reconnaissance and ASW role seems to suggest that he is trying to argue the strategic significance of the submarine in general, versus being confined to a particular weapons system that a certain submarine may carry. By arguing a submarine's strategic significance, a point can be made directly to its necessity in national defense and the importance that must be put on maintaining such a system in the future. Whether or not a submarine is actually strategic or not, in the Soviet sense, is not the point. The fact is that the author tries to make the point of the submarine's importance to the readers. If the book was solely intended to be used as a reference document or instructional tool for naval officers, as noted in the publications distribution footnote, the significance of submarines would not have to be stressed so strongly so as to infer their importance on the strategic level.

The importance of reading Soviet literature and understanding it from a Soviet perspective can not be over emphasized. Taktika Podvodnykh Lodok offers excellent insight into the Soviet mind-set in terms of the utilization and application of submarine warfare. Along with the first views of how the Soviets conduct submarine warfare the book allows the thoughtful reader insight into how a Soviet uses specific words and themes to make a point about the necessity or usefulness of a system in the midst of a budgetary debate, such as the ongoing one with respect to "reasonable sufficiency" within the Soviet military, in the context of a seemingly diverse publication. ■

BULLETIN BOARDS

DO YOU HAVE ONE AT WORK?

• • • IF SO • • •

PLEASE POST AN NSL INFORMATION BROCHURE

and

MEMBERSHIP APPLICATION

Call Pat Lewis at (703) 256-0891
to replenish your supply of materials.

REUNIONS

USS GUARDFISH (SSN 612)
Deactivation Ceremony
14 June 1991 in San Diego, CA

Former crew members and all interested in attending, contact:

Commanding Officer
USS GUARDFISH (SSN 612)
FPO SAN FRANCISCO 96666-2323
(619) 553-9001/9002

• •

USS ROBERT E. LEE (SSBN 601) Gold Crew
20-21 September, 1991 -- Groton, CT.

Contact: CDR G. P. Shaddock
125 Elm Avenue
Satellite Beach, FL 32937
(407) 777-2453

• •

USS TORSK (SS 423)
September 28, 1991, in Baltimore, MD
and
USS JOHN MARSHALL (SSBN 611)
Is planning a reunion for Spring 1992

Contact: Pete Gunn
3 Green Valley Lakes Road
Old Lyme, CT 06371.

Please include a business-size, self-addressed, stamped envelope

• •

U.S. SUBMARINE VETERANS OF WORLD WAR II
37th Annual National Convention
San Antonio, Texas
October 2-6, 1991

Details: (407) 452-3819

• •

The Admiral Nimitz Foundation
Remembers World War II in the Pacific

Over the next four years, the Admiral Nimitz Museum and Foundation will be observing and reviewing many of the events that highlighted the war of the Pacific. The first of a series of symposia will be held in Austin, Texas on May 9-11, 1991.

Non-members of the Foundation can learn details by writing to P.O. Box 777, Fredericksburg, TX 78624-9967, or by calling (512) 997-4379.

• •

ATTENTION SUBMARINE MODELERS!

Scale Ship Modelers Association (SSMA) is holding a seminar at the North Island Naval Air Station in San Diego, California, on July 13-14, 1991. All those interested in more information please write to:

SSMA/SUBPAC SEMINAR
15125 Hesta
Poway, CA 92064

Registration deadline is May 24, 1991

■

NROTC OUTSTANDING ACHIEVEMENT AWARDS

Congratulations to the following NROTC seniors who have been awarded the Naval Submarine League Outstanding Achievement Award. Each winner has volunteered for and has been accepted into the Submarine Training Program.

Edward L. Butts	Hampton University
Mathew Aaron Dixon	University of Minnesota
Paul R. Crowley	Boston University
Brian D. Archibald	University of California Berkeley
Michael D. Bratton	University of Colorado
Eric Robert Schneider	Cornell University
Carlos J. Rodriguez	Carnegie Mellon University
Darryl D. Drennan	Duke University
Michael W. Wilkerson	University of Florida
Michael R. Ling	Georgia Institute of Technology
David M. Peters	The George Washington University
Philip Miller	College of The Holy Cross
Leslie Bonner Smith	The Citadel
Scott A. Maier	University of Illinois
Daniel W. Bedford	Illinois Institute of Technology
Michael B. Kellerman	Iowa State U./Science & Technology
Kip M. Shepard	University of Kansas
Edward Stuart Hunter	Oregon State University
Joseph M. Poellnitz	Massachusetts Inst. of Technology
Raymond Alexander	Memphis State University
Stephen H. Smith	University of South Carolina
Steven Hall	The University of Michigan
John J. Brown	The Tulane University of Louisiana
Edward P. Meintzer	Northwestern University
Michael Allen Leitner	University of Notre Dame
Kenneth L. Worthy	The Ohio State University
Jeffrey T. Heydon	University of Oklahoma
John Vlattas	University of Pennsylvania
Brent M. Voelker	Rensselaer Polytechnic Institute
Timothy L. Jones	University of Rochester
Marshall R. Prouty	U. of San Diego/San Diego State U.
William Joseph Swanson	University of Southern California
Kevin M. Byrne	State Univ. of NY Maritime College
Richard Healey	The University of Texas at Austin

Mark A. Harrington	Vanderbilt University
William J. Patterer	Villanova University
James Michael Johnston	University of Virginia
John D. Shorter	Virginia Military Institute
Perry Dean Meyer	The University of Wisconsin
Andrew B. St. John	Rice University
Robert Keeling	University of Missouri
Michael C. Nance	University of Arizona
Douglas A. Jordan	Auburn University
Eugene J. Nemeth	The Pennsylvania State University

■

ACTIVE DUTY SUBMARINE ESSAY CONTEST WINNER

Congratulations to Lieutenant Wade H. Schmidt, USN, for winning our 1990 Active Duty Submarine Essay Contest. The Winning article was titled: **Building a Survivable Submarine Force.**

Honorable mentions were awarded to:

LT David M. Osen, USN:
Vigilance

LCDR Ronald W. Lubatti, USN:
The Decline of the Industrial Base

LCDR David Olmstead, USN:
Submarine Roles and Missions in the Detente II Era

■

NAVAL SUBMARINE LEAGUE
HONOR ROLL

BENEFACTORS FOR FIVE OR MORE YEARS

1. ARC PROFESSIONAL SERVICES GROUP, DEFENSE SYSTEMS DIV.
2. ALLIED-SIGNAL AEROSPACE COMPANY
3. AMERICAN SYSTEMS CORPORATION
4. ANALYSIS & TECHNOLOGY, INC.
5. ARGOSYSTEMS, INC.
6. BABCOCK AND WILCOX COMPANY
7. BATTELLE MEMORIAL INSTITUTE
8. BENDIX OCEANICS INC.
9. BIRD-JOHNSON COMPANY
10. BOEING AEROSPACE COMPANY
11. BOOZ-ALLEN & HAMILTON, INC.
12. DATATAPE, INC.
13. EDO CORPORATION
14. ELECTRIC BOAT DIVISION OF GENERAL DYNAMICS
15. ELIZABETH S. HOOPER FOUNDATION
16. ERIE FORGE AND STEEL (Formerly National Forge)
17. ESSEX CORPORATION
18. FMC CORPORATION
19. GE AEROSPACE
20. GNB INDUSTRIAL BATTERY COMPANY
21. GTE GOVERNMENT SYSTEMS CORPORATION
22. GENERAL DYNAMICS/ELECTRIC BOAT DIVISION
23. GENERAL ELECTRIC MARINE & DEFENSE FSO
24. GENERAL ELECTRIC OCEAN & RADAR SYSTEMS DIVISION
25. GENERAL PHYSICS CORPORATION
26. GLOBAL ASSOCIATES, LTD.
27. HAZELTINE CORPORATION
28. HUGHES AIRCRAFT COMPANY
29. IBM CORPORATION, FEDERAL SECTOR DIVISION
30. KAMAN DIVERSIFIED TECHNOLOGIES CORPORATION
31. KOLLMORGEN CORPORATION, E-O DIVISION
32. LIBRASCOPE CORPORATION
33. LOCKHEED CORPORATION
34. LOCKHEED SANDERS INC. (formerly Sanders Associates, Inc.)
35. LORAL CONTROL SYSTEMS
36. LORAL DEFENSE SYSTEMS - AKRON
37. NEWPORT NEWS SHIPBUILDING
38. NORTHROP CORPORATION
39. PRC, INC. (Formerly Advanced Technology)
40. PACIFIC FLEET SUBMARINE MEMORIAL ASSOCIATION
41. PRESEARCH INCORPORATED
42. PURVIS SYSTEMS, INC.
43. RAYTHEON COMPANY, SUBMARINE SIGNAL DIVISION
44. ROCKWELL INTERNATIONAL CORPORATION
45. SAIC
46. SCIENTIFIC ATLANTA, GOVERNMENT PRODUCTS DIVISION
47. SIPPICAN, INC.

48. TITAN SYSTEMS, INC.
49. TREADWELL CORPORATION
50. VITRO CORPORATION
51. WESTINGHOUSE ELECTRIC CORPORATION

ADDITIONAL BENEFACTORS

1. ADI TECHNOLOGY CORPORATION
2. AT&T
3. ALLIANT TECHSYSTEMS
4. APPLIED MATHEMATICS
5. ARETE' ASSOCIATES
6. BELL AEROSPACE TEXTRON
7. CAE/LINK TACTICAL SIMULATION
8. COMPUTER SCIENCES CORPORATION
9. CORTANA CORPORATION
10. DSDJ, INC.
11. DEFENSE - MARINE MARKETING, INC.
12. EG&G SEALOL ENGINEERED PRODUCTS DIVISION
13. ESL INCORPORATED
14. FOSTER-MILLER, INC.
15. GENERAL DYNAMICS/UNDERSEA WARFARE
16. HYDROACOUSTICS, INC.
17. INTEGRATED SYSTEMS ANALYSTS, INC.
18. INTERSTATE ELECTRONICS CORPORATION
19. KPMG PEAT MARWICK
20. MARTIN MARIETTA AERO & NAVAL SYSTEMS
21. MCQ ASSOCIATES, INC.
22. NOISE CANCELLATION TECHNOLOGIES, INC.
23. PAC ORD INC.
24. PHYSICAL DYNAMICS INC.
25. PLANNING SYSTEMS INCORPORATED
26. RADIX SYSTEMS, INC.
27. RIX INDUSTRIES
28. SARGENT CONTROLS
29. SEAKAY MANAGEMENT CORPORATION
30. SIGNAL CORPORATION
31. SOFTECH, INC,
32. SONALYSTS, INC.
33. SPACE & MARITIME APPLICATIONS CORPORATION
34. SPERRY MARINE INC.
35. STONE AND WEBSTER ENGINEERING CORPORATION
36. SYSCON CORPORATION
37. SYSTEMS PLANNING & ANALYSIS, INC.
38. TASC, THE ANALYTIC SCIENCES CORPORATION
39. TECHNAUTICS CORPORATION (formerly Argo-Tech)
40. TRIDENT SYSTEMS, INC.
41. UNIFIED INDUSTRIES, INCORPORATED

PATRONS

GEORGE S. ZANGAS

NEW SKIPPERS

CDR GREGORY M. VAUGHN

NEW ADVISORS

CHESTER L. LONG

NEW ASSOCIATES

CAPT JAMES L. McVOY, USN(RET.)
RADM HARVEY E. LYON, USN(RET.)
LT FRANKLIN D. VOORHEES, USNR
CDR MICHAEL E. RIORDAN, USN
CAPT ARTHUR F. RAWSON JR., USN(RET.)
RADM ARLINGTON F. CAMPBELL, USN
CDR DONALD O. BURRELL, USN(RET.)

REMEMBERING THE NAVAL SUBMARINE LEAGUE

As you have your will drafted or revised, we hope that you will remember the Naval Submarine League. It is through your continuing support that the Naval Submarine League will be able to grow and make a difference and contribution to enhance the public's support for the Submarine Services.

There are many different ways to include the Naval Submarine League in your will. You may want to make an outright bequest of cash, stock or other property to the Foundation. Or, you may prefer a plan that would first provide for the benefit of your family members during their life-times, after which time certain designated assets of yours would be distributed to the League. It is also possible to name the Naval Submarine League as a contingent beneficiary. For example, you may provide for the League to receive cash or other property from your estate only if others named in your will are not living at the time of your death.

We would be pleased to provide you or your attorney with more information on how you can support the Naval Submarine League and its work through your will.

■

REMEMBER

THE DATES FOR THE 1991

NINTH ANNUAL SYMPOSIUM

are

JUNE 12-13, 1991

at the

RADISSON MARK
PLAZA HOTEL
Alexandria, Virginia

-- DON'T GET LEFT OUT --

SEND RESERVATIONS IN NOW!

SAVE ON SYMPOSIUM TRAVEL!

American Airlines, in cooperation with the Naval Submarine League is offering a Meeting Saver Fare that allows a 40% discount off their round-trip, unrestricted day coach fare for attendees travelling within the USA on American to the meeting. (Note: There is a $30.00 service fee on the special discount only if tickets are returned for refund.)

In addition to the above discount offer, AA offers 5% off the lowest applicable round-trip fare, subject to availability of inventory. All fare rules and restrictions apply. The 5% discount also applies to round-trip first class travel.

Travel to Washington, DC, must be between June 11-16, 1991. Reservations must be made and tickets purchased at least 7 days before departure to secure a 40% discount.

American will confirm reservations for you at the lowest rate available, providing normal qualifications are net.

The Meeting Saver Fare offer is available only through the number listed below for American's Meeting Services Desk. Reservations for any promotional fare, including the Ultimate Super Saver Fare, can also be made through them. If you normally use the service of a travel agent, please have them place your reservations through the number below to obtain the same advantages for you.

CALL TOLL FREE . . . . ASK FOR STAR # 5-07614D
1-800-433-1790
7:00 AM - 12:00 Midnight Central Time
Seven days a week

MEMBERSHIP STATUS

	Current	Last Review	Year Ago
Active Duty	982	988	961
Others	2833	2853	2883
Life	215	211	174
Student	26	26	28
Foreign	72	73	63
Honorary	25	25	20
Total	4153	4176	4129

PLEASE RECRUIT 2 NEW MEMBERS FOR 1991!